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Furnace Interests Control the Distribution of Iron

Essential Industries, Including All Making Direct and Indirect Government Work, Will First be Supplied and the Balance Will be Divided Among the Nonessentials

OF the utmost importance and interest to foundrymen is the announcement that the priorities committee of the war trade board will exercise no control over the blast furnace output. The distribution of iron is being handled by J. C. McLauchlan, chief of the pig iron section; J. Leonard Replogle, steel director and H. G. Dalton, chairman of the subcommittee on pig iron, iron ore and lake transportation of the American Iron and Steel institute, and in some instances, by Leonard Peckitt, eastern representative of the committee. Director Replogle has sent a letter to the trade in which he states that it has been decided not to issue priority certificates on pig iron made in the absence of instructions from him to the contrary, producers of pig iron will distribute their product in accordance with the schedule of purposes entitled to preference treatment, outlined in the war industries board resolutions of June 6. As interpreted, this letter means that the blast furnace operators are to have practical control of the distribution of the pig iron production, first supplying the essential needs and whatever remains may be delivered to the nonessential industries. According to this procedure, the direct and indirect government requirements, including ordnance, shipbuilding and railroad needs, will be supplied first and only in sufficient tonnage for such work, and whatever surplus remains is to be distributed at the discretion of the blast furnace operators for nonessential production.

By this ruling the hoped for definition of nonessentials will not be made, although all operations that are not included among direct and indirect government needs are classified in the nonessential list. Since the foundrymen have furnished the blast furnaces from which they buy pig iron, a complete schedule of their requirements, their metal supply will be delivered to them in the proportion of their essential needs. The tonnage of iron that will be divided among the foundries making castings for nonessentials cannot even be guessed. This depends entirely upon the requirements of the government. Thus far the casting industry has not suffered greatly, but the situation is liable to sudden and violent changes. A statement has just been issued that the iron and steel for war purposes the remainder of the year will total 20,000,000 tons, which is considerably in excess of the production in any like period in previous years. If this is the case, the balance of pig iron for nonessential work will be so small that it will be inconsequential and cannot be counted upon. Furthermore, stocks of pig iron in foundry yards which have no essential work, may be commandeered for shipment to plants engaged on government work. This is a feature of the situation that is most distressing to foundrymen who believed that their stocks would be a guarantee against a future shortage. To tide over the pig iron shortage, however, foundrymen throughout the country are resorting to the use of a greatly increased amount of scrap in their mixtures. In many cases as high as 85 per cent is being charged and in some instances all-scrap is being employed. This practice has proved successful with the judicious use of ferroalloys. On the other hand, the foundry coke supply is satisfactory and numerous sales through the first half of next year have been recorded.

Pig iron buying for 1919 delivery is in large volume and is estimated at several hundred thousand tons since July 1. The iron is being purchased by

The War and the Foundry Industry

Pig iron distribution will be in control of the producers and will be allotted on the basis of essentials as outlined by the government several months ago. No definition of nonessentials has been attempted, nor will one be made. War needs, with all of their ramifications, must first be met and any tonnage left over will be distributed to the best advantage by the iron producers.

Purchases of pig iron for 1919 delivery are being made in large volume by consumers engaged in essential lines.

Orders for approximately 600,000 cast iron car wheels have been placed involving nearly 50,000 tons of iron.

The army ordnance department contemplates the purchase of 500,000 semisteel shells in the near future. Specifications covering the manufacture of these projectiles have been issued.

Graphite and graphite crucibles have been placed on the list of restricted imports for the remainder of the year.

consumers engaged in essential lines of production. Furnace operators see a considerable advantage in a more satisfactory credit situation by taking this business ahead, instead of waiting for their books to be filled with indiscriminate government allocations. Under the prevailing conditions of restricted buying, furnace order books have been running down steadily and makers are beginning to evince a great interest in restoring some of this tonnage. Increased production of basic iron in the south at the expense of foundry iron will result from the distribution of about 80,000 tons of basic to fill a British order.

Orders for approximately 600,000 cast iron car wheels which will require approximately 50,000 tons of pig iron have been awarded by the railroad administration. The distribution of these car wheel contracts was made as follows: American Car & Foundry Co., 248,000; Griffin Wheel Co., 126,000; Haskell & Barker Car Co., 64,000; Pressed Steel Car Co., 56,000; Mount Vernon Car Mfg. Co., 32,000, and the National Steel Car Co., 20,000.

Further revisions and amplifications of existing fixed schedules of base prices, differentials and extras for iron and steel foundry scrap have been annulled by the committee on steel and steel products of the American Iron and Steel institute. The statement follows:

Substitute the following for the corresponding paragraphs in the recommendations of Feb. 21, 1918, as shown on pages 14a, 14b and 14c of the institute pamphlet of January, 1918. (Pages 20-22 of revised Penton Publishing Co. booklet.)

No. 2 Low Phosphorus Steel

(c) Steel knuckles and couplers, rolled steel wheels, railway springs, carbon steel and similar material in quality and character which will analyze 0.06 and under in phosphorus and sulphur, may be dealt in for use in such plants at a differential of not exceeding $5 per gross ton above the base price of heavy melting steel...Maximum, $34.

No. 3. Steel rails 3 feet and under, steel splice bars and steel rails, structural steel or similar scrap which has been especially sheared to short lengths for use in cupolas, hand-charging furnaces or for rerolling purposes, may be dealt in at a differential of not exceeding $5 above the base price of heavy melting steel.....Maximum, $34.

No. 8. Cast Iron Scrap

(a) All cast iron scrap, whether broken or unbroken, including cast iron car wheels, may be dealt in at a maximum price of not exceeding that of heavy melting steel, except as noted in Clause B.....Maximum, $29.

Note.—Burnt iron, burnt grate bars, stove plate, brake shoes, soil pipe and all other inferior grades of cast scrap may not be dealt in at any price in excess of the maximum price of heavy melting steel.

(b) Strictly No. 1, cast iron scrap in cupola shape, in pieces not exceeding 150 pounds, when suitable for and to be used only in cupolas or in puddling furnaces, may be dealt in at a differential of not exceeding $5 per ton over the maximum price of heavy melting steel.....Maximum, $34.

Graphite crucibles now have been placed on the list of restricted imports, following the action of the war trade board restricting the importation of graphite through the remainder of the year. All outstanding licenses for the importation of graphite crucibles have been revoked as to ocean shipments after July 15, 1918, and no licenses for the importation of this commodity for shipment after that date will be granted for the rest of the calendar year. The result of the restriction of graphite imports has been to develop an adequate supply of graphite within the country. The difficulties involved in the shipments of Ceylon graphite since the beginning of the war has resulted in a tremendous increase in the output of the mines on the North American continent. In the United States the total production of crystalline graphite including stocks on hand at the mines was about 14,000,000 pounds in 1917 as against 10,900,000 pounds the previous year. A part of the greater demand for crucibles during the last two years has been due to the lower life of pots made with domestic clays, as compared with those from Bavarian clay, shipments of which were cut off late in 1914. Therefore, a larger number of crucibles was required to perform the same work. However, the difficulty of obtaining satisfactory clay for use in crucibles has been largely overcome and the crucibles now made with domestic clay give practically the same number of heats as those formerly produced with imported German clay. Figures furnished the United States geological survey by the producers of crystalline graphite show that out of total sales of 10,584,080 pounds in 1917, 6,816,913 pounds, valued at $982,336, or about 64 per cent by weight and 90 per cent by value of the total, was flake graphite which contained from 80 to 90 per cent of graphitic carbon, in large part suitable for making crucibles. The remainder, namely, 3,767,177 pounds, valued at $109,962, was dust or low grade flake which probably averaged under 50 per cent of graphitic carbon. The proportion of flake graphite produced was greater than in previous years, the increase having been due in part to improved methods of milling whereby a larger proportion was saved as flake and in part to the fact that owing to the freight embargo during the latter part of the year the Alabama producers were able to ship only material of high grade.

About 30,000 tons of graphite suitable for crucible manufacture will be needed in 1918. The figures available indicate that the domestic production of 10,000 tons of flake graphite in 1918 is well within the capacity of the mills already established or under construction. This is more than the amount of domestic material usually required by crucible manufacturers and unless the crucible trade should use a larger proportion of the domestic product than formerly, many mills will have difficulty in disposing of their graphite. The freight and market conditions, as well as an improved labor situation favor the shipment of domestic graphite. About 8000 tons of flake graphite of crucible grade, exclusive of dust, can be marketed in this country this year, an increase of more than 100 per cent over the production in 1917. If the domestic output could be stimulated to its

Government Price Book

Government regulation of iron, steel and metal prices has produced so many rulings, quotations, differentials and extras, that it is difficult for buyers and sellers to maintain an accurate record of developments. For this reason a booklet has been compiled by the Penton Publishing Co., publishers of THE FOUNDRY, *which contains all of this information in concise form. Government prices of pig iron, scrap, malleable iron and steel castings, coke, nonferrous metals and steel products of all kinds are included. In addition, it embraces all official announcements and rulings of importance on prices, sales, priorities and general distribution; full directory of price authorities of the war industries board and of the lake trade; comparative open and controlled market prices, charts, etc. Its 75 pages comprise a manual of government regulation. Furnished by* THE FOUNDRY, *Cleveland, at $1 a copy, including delivery.*

maximum capacity, reasonable assurance of a steady market given and encouragement offered to new plants, a production as high as 12,000 tons might be reached. The situation is more favorable with respect to noncrucible graphite. The requirements for this year will be between 28,000 and 32,000 tons, which probably may be supplied by domestic, artificial and Mexican production.

The crystalline graphite for making crucibles should contain as high as 85 per cent of graphitic carbon and should be free from any pyrite and iron oxide which are particularly harmful impurities. Preferably, it should contain a large proportion of flakes, 1 millimeter or more in diameter, so that its fragments may interlock and thus be bound more easily together by the clay with which it is to be mixed. Most makers of crucibles prefer to use a mixture of Ceylon graphite with American flake. Ceylon graphite is more nearly free from impurities and its more nearly cubical fragments have a much smaller surface area in proportion to their volume than the thin flakes of domestic graphite, therefore requiring less clay as a binder. Domestic flake graphite may be used alone for making crucibles, but as the domestic production cannot yet be increased sufficiently to supply the needs of the crucible manufacturers, graphite imported from Ceylon and Madagascar must still be used. The only American graphite resembling that from Ceylon is found in Montana, but the quantity produced is small.

Specifications for Semisteel Projectiles

TESTS of experimental cast semisteel projectiles have proven so favorable that an initial order of 500,000 probably will be placed by the ordnance department of the army in the near future. As previously poinited out in these columns, experimental shells were made by a number of foundries that were tested at the Aberdeen, Md., proving grounds. As a result of these tests and the practice and experience of the casting shops where these projectiles were made, specifications have been prepared which provide only for physical tests and make no reference to the chemical properties of the metal from which the shells are to be made. Also, no reference is made to the mixture, nor to the amount of steel to be used. The tensile strength of the test specimen must be at least 32,000 pounds per square inch and a rigid impact test also is provided. Projectiles to be used for gas shells shall be coated with a soap solution and shall be subjected to an air pressure of 100 pounds per square inch for 30 seconds, without evidence of the formation of soap bubbles during this test. The specifications for semisteel projectiles follow:

PROJECTILES will be cast from semi-steel, with a riser having a volume sufficient to insure sound metal free from segregation and porosity.

PHYSICAL TESTS

Test bars shall be taken from the pouring ladle at each cast and each test bar shall be cast in a vertical baked sand mold from which it shall not be removed until it no longer shows the color of heat.

The physical tests shall consist of a tensile strength test and an impact test, and in each test if the first test specimen meets the requirements the test shall be considered to have been passed. If the first specimen tested fails to pass the test, two substitute specimens may be submitted, both of which must meet the specified requirements in order to pass the test.

In case a test specimen fails on account of the presence of physical defects, such as blow holes, cold-shuts, or the like, a new test bar may be submitted in its place, and the specimen so failing shall not be considered as a test.

(a) Tensile Strength Test

The test bar shall be cast 1¼ inches in diameter, with a length of 8 inches and a riser of 4 inches. After removal of the riser the test specimen will be machined to a diameter of 1.128 inches for a minimum length of 4 inches. The tensile strength of the specimen must be at least 32,000 pounds.

(b) Impact Test

The test specimen, 1½ inches square and not exceeding 1.52 inches on any side, shall be cast with a length of 8 inches and a riser of 4 inches. After removal of the riser the bar will be placed on two knife edge supports 6 inches apart, which in turn are supported by an anvil weighing at least 1750 pounds. A weight of 25 pounds will be caused to fall exactly on the middle of the test bar. The test will begin with the weight at a height of 12 inches and the test will be repeated with the height of the weight increased by ½ inch intervals until the bar breaks. The height of fall for causing rupture will be not less than 18 inches, this height being measured from the upper surface of the bar to the lowest part of the testing weight.

Test bars may be machined for a width of ¼ inch at the lines of bearing on the knife edge supports.

The impact testing machine shall be made in accordance with drawings of the ordnance department and must be approved by the government inspector.

INSPECTION

Certified copies of physical tests shall be supplied to the government inspector, and all physical tests shall be conducted in his presence. In case the casting and machining operations are conducted by different manufacturers, both the castings and machined projectiles will be inspected by a government inspector. When the casting and machining operations are performed by the same manufacturer, the government inspection of castings may be waived.

Certified copies of chemical analyses shall be supplied to the government inspector for such casts as he may specify.

(a) Inspection of Castings

Castings must be free from blisters, blow holes and cracks, except that slight imperfections may be allowed on the outside of the casting in front of the position to be occupied by the rotating band, provided that they do not extend to a depth more than one-fourth of the thickness of the wall and do not exceed ⅛ inch in diameter. The castings shall be free from sand, both inside and outside, before being submitted for inspection. The inside of castings shall be smooth and in the case of castings for high explosive shell shall be sand or shot-blasted or rumbled in a manner satisfactory to the government inspector.

Each casting on being struck with a hammer must give a clear metallic ring; those giving a dull sound will be rejected.

The castings shall be capable of being readily chipped, filed and machined.

Risers shall be removed from the castings before submitting them for inspection.

At the option of the inspector, an occasional casting may be fractured to determine the soundness of the metal. Castings so fractured shall not exceed 1 per cent of the total.

(b) Inspection of Machined Projectiles

Projectiles shall conform to the dimensions shown on the drawing. The inspection for blow holes and other imperfections in the machined projectiles shall be the same as prescribed above for castings. If, in the process of machining, blow holes or other imperfections are developed, the government inspector shall be notified immediately and work shall be continued only by his authorization.

Projectiles to be used for gas shells shall be coated with a soap solution and subjected to an air pressure of 100 pounds per square inch for 30 seconds. There must be no evidence of the formation of soap bubbles during this test.

All projectiles shall be subjected to a hydraulic test for 15 seconds. Projectiles of 6-inch caliber and less shall be tested at 4500 pounds per square inch, and projectiles of caliber larger than 6 inches shall be tested at 3000 pounds per square inch. All projectiles showing any leakage or permanent expansion of more than 0.001 inches per inch of caliber, approximately ½ inch in rear of the bourrelet, shall be rejected and mutilated in such manner as to prevent them from being resubmitted.

The air test and hydraulic test shall be performed before banding, and, in the case of gas shells, the air test shall precede the hydraulic test.

All shells shall be thoroughly dried after the hydraulic test.

No white or red lead shall be used in any operation of the manufacture of high explosive shells.

BANDING

The copper band will be pressed into its seat in such manner as to be securely fastened to the projectile, and this will be tested by tapping with a small hammer and the occasional removal of a band for examination. The finished band must be tough and in uniform condition. A removed band must be capable of being bent around a round bar of a diameter equal to the thickness of the band without showing cracks. Replacement of new bands for those failing on the test shall be at the expense of the contractor, and for those meeting the test, at the expense of the government.

REJECTED PROJECTILES

In case the casting and machining operations are performed by different contractors, the following provisions will apply:

(a) If projectiles are rejected at the plant of the machining contractor on account of defects in the castings, such castings shall be replaced by the foundry contractor or the government shall be reimbursed for the value of the same.

(b) The machining contractor will reimburse the government for the value of castings rejected due to defects in machining operations for which he is responsible.

FACILITIES FOR INSPECTORS

Inspectors and other duly accredited representatives of the government will have free entry at all times to all parts of the manufacturer's plant which concern the manufacture of the material ordered. The manufacturer will afford the government representatives free of cost, all reasonable facilities to satisfy them that the material is being furnished in accordance with these specifications. All the tests and inspections will be made at the place of manufacture prior to shipment and will be so conducted as not to interfere unnecessarily with the operation of the plant. The manufacturer will provide within his plant a suitably furnished office for records, drawings, books, etc., to be used exclusively by the government representatives.

GAGES

The manufacturer will provide all the gages needed for the manufacture and inspection work except that the government will, in general, provide the inspectors with a set of reference inspection gages covering the important dimensions to be gaged. These will be available for reference purposes. A satisfactory system of gage inspection and checking must be maintained by the manufacturer. Inspection gages will be inspected and checked by the government inspector. Drawings of all gages will be submitted by the manufacturer for approval.

MARKING

(a) When the casting and machining operations are performed by different manufacturers, each casting shall be permanently marked with the cast number and symbol of the foundry and accepted castings shall be stamped by the government inspector. The machined projectiles made from such castings shall be stamped with the cast number, the symbol of the foundry and the symbol of the machiner, and after acceptance shall be stamped by the government inspector.

(b) When the casting and machining operations are performed by the same manufacturer, the finished projectile shall be stamped with the cast number and the symbol of the manufacturer, and after acceptance shall be stamped by the government inspector.

VARNISHING, PAINTING AND PACKING

Varnishing, painting and packing shall be performed in accordance with current specifications.

Electric Furnace War Service Board Organized

ELECTRIC furnace manufacturers have organized a war service committee for the purpose of compiling information relating to the electric furnace industry in connecton with the production of steel, nonferrous alloys and metals, and in general where the melting problem is concerned. This committee will continue for the duration of the war and for such a period thereafter as is necessitated by the demands of the government for information regarding this industry. At a recent meeting held in New York city, the following permanent committee was elected: G. H. Clamer, Ajax Metal Co., Philadelphia, chairman; F. J. Ryan, Electric Furnace Construction Co., Philadelphia, secretary; John G. Bergquist, Hamilton & Hansell Co., New York; S. N. Castle, General Electric Co., New York, and C. B. Fletcher.

The following companies are affiliated with this war service committee: Hamilton & Hensell Co., New York; John A. Crowley Co., New York; Ajax Metal Co., Philadelphia; American Metallurgical Corp., Philadelphia; Electric Furnace Construction Co., Philadelphia; Pittsburgh Furnace Co., Pittsburgh; Booth-Hall Furnace Co., Chicago; Industrial Electric Furnace Co., Chicago; C. W. Leavitt & Co., New York; Ludlum Electric Furnace Co., Woolworth building, New York; T. W. Price Engineering Co., New York, and Beckman & Linden Corp., San Francisco.

The first meeting held in May was called at the request of the general war service committee of the electrical manufacturing industry. At that time the suggestion was made that the electric furnace manufacturers should effect an organization to act under this general war service committee and to furnish information regarding the electric furnace industry to the government in its war preparations.

Government Wants Combustion Engineers

The oil division of the United States fuel administration desires to secure a combustion engineer for each of the following districts, who will act as an inspector visiting all plants within his district using fuel oil and natural gas: Boston, Providence, New York City, Philadelphia, Pittsburgh, Buffalo, Detroit, Chicago, Minneapolis, Tulsa, New Orleans and San Francisco. These men are to act as volunteers if possible, although the government is prepared to pay a reasonable compensation for men who cannot afford to give this service gratis. Only men who have had experience in fuel oil and natural gas combustion will be of value.

Moisture in Coke

By David McLain.

In the July issue of THE FOUNDRY, page 339, was published an article by E. H. Schwartz under the caption, "Keep Your Coke Dry," in which it was pointed out that for the purpose of conserving fuel for foundry operations, coke should be kept under cover. The writer does not agree with the recommendations made since he has had years of experience with both dry and wet coke and he has never found any difference in the fuel consumption of the two. If wet coke is charged on the bed, it surely will have dried out before the blast is put on, and if wet coke is used between the charges, the water certainly evaporates before the coke reaches the melting zone. Perhaps Mr. Schwartz refers to the old system of melting iron, which involved filling the cupola to the charging door before lighting, and starting the blast immediately after doing so. Since conservation of coke is of the utmost importance, I hope that Mr. Schwartz will give additional information on this vital subject. Heretofore, the only objection the writer has had to moisture in coke was before shipment, as wet coke, of course, weighs more per unit than dry coke.

A booklet, entitled "The Proper Care of Belts", which contains helpful suggestions for getting maximum efficiency from belts, has been issued by the Joseph Dixon Crucible Co., Jersey City, N. J.

The Multi-Metal Separating Screen Co., 251 West Nineteenth street, New York, has been incorporated under the name of the Multi-Metal Co. No change in the management or business policies of the company is contemplated. The Multi-Metal Co. manufactures special protection devices for sand-blast work.

How Dummy Iron Shells Are Molded and Cast

A Two-Part Flask is Employed and Most of the Mold is In the Cope — Special Gating Arrangements Necessary

By H Cole Estep

A FEW MONTHS ago many gray-iron foundrymen were of the opinion that their direct participation in the support of our armies in the field would be negligible. This belief was the result of a lack of knowledge of the conditions of modern warfare, and as our military plans assumed shape it became evident that iron foundrymen would be called upon to play as important a role as their colleagues in the steel-casting business. First came large orders for hand and rifle grenades. These were followed by contracts for trench-mortar bombs and orders for large semisteel shells.

More recently gray-iron foundrymen have found it necessary to turn their energies in still another direction. The rapid expansion of our armies, coupled with the establishment of huge training camps, has created a demand for a large number of dummy shells to be used for instruction purposes. They figure prominently in the primary exercises of embryo artillerymen, and convey to the tender muscles of the drafted soldier the first taste of war's stern realities. In every detail these shells are replicas of the real thing. They are made of gray iron and are cast in green-sand molds with dry-sand cores. Thousands of them have been ordered.

The Globe Stove & Range Co., Kokomo, Ind., is casting 8100 dummy shells of the 6-inch size. They weigh 50 pounds each. Don't imagine that because they are used simply for practice they can be made in a go-as-you-please fashion. The specifications are virtually as strict as for the heavy 6-inch rifled, semisteel field artillery shells. The practice shells must be accurate in size and weight; the finish must be flawless; the balance, or hang, as the artillerymen call it, must be correct; the core must be properly centered, and the composition of the metal must accord with the specifications. Throughout the manufacturing process continuous care and constant inspection is required. To obtain a uniform product and an output commensurate with conditions of the contract, the Globe Stove & Range Co. uses molding machines extensively on its dummy-shell floors. A two-part cast-iron flask of special shape is employed. Practically all of the mold is in the cope, which is made on a 24x10-inch, hand-operated, turn-over draw machine furnished by the International Molding Machine Co., Chicago. An iron pattern is fitted on the machine. The drag is molded on a bench using a simple metal roll-over board. Four men turn out 80 to 100 molds a day, with losses averaging only 2 per cent. The gang consists of one molder and three helpers. The molder and one helper work the machine; the third man makes the drags and the fourth sets cores and assists in closing the flasks. As previously indicated, the molds are made in green sand with a dry-sand center core. The latter must be carefully formed and accurately set and centered by means of gages. Also it is necessary to provide means for steadying the upper end of the core so it will not be shifted to an eccentric position while pouring.

FIG. 1—THE COPE IS MOLDED ON A TURN-OVER DRAW MACHINE USING A METAL PATTERN

The metal must have the correct composition, or trouble will be experienced with shrinkage, particularly at the nose of the shell. Also it must be poured properly and at the right temperature. Above all it is essential that it be clean and free from slag. To this end, a specially designed skim-gate provided with two skimmers and a whirling basin to catch slag has been provided. This arrangement, together with the other details of the job, was worked out by George B. Jones, general superintendent of the Globe Stove & Range Co. The cope is formed in the shape of a truncated cone, 15½ inches high, with an inside diameter of 12 inches at the top and 11 inches at the bottom. A lip in which the pouring runner is carried is formed on one side of the cope. It measures 5½ inches across. In addition, the cope is fitted with ears to engage the flask pins on the drag. Lugs also are cast on the side of the cope for convenience in handling. Fig. 1 shows the cope on the machine just after the pattern has been drawn. The general arrangement of the mold and the position of the pouring lip and runner are clearly shown. Fig. 4 is another view of the molding machine, showing the pattern ready to receive the cope which may be seen standing on the floor in the foreground. It will be noted that the cope is designed to reduce the consumption of sand to a minimum. A floor of completed molds is shown in Fig. 6. This represents half a day's work by one mold-

FIG. 2—DETAILS OF DRY-SAND SLAG BASIN AND SKIM-GATE PARTS WITH COREBOXES

ing machine gang. The drag flask, which is also cast iron, is clearly illustrated in Fig. 5. It is 11 inches in diameter and 3 inches deep. It acts primarily as a base for the mold and contains the skim-gate and main core-print. It is rammed-up by hand on the plate shown in the foreground in Fig. 5. One man makes all the drags for a floor. The drags are set on wooden bottom-boards.

The Skim-Gate

The details of the skim-gate are shown in Figs. 2, 4 and 5. The runner extends clear through the cope, the metal entering the mold from the bottom. The gate consists of the slag basin *B* Figs. 1, 2 and 4, and the dry-sand skimmer *S*, Fig. 2. The latter is shown in position in the drag in Fig. 5. The slag basin is also dry sand. The corebox in which it is made is shown at *C*, Fig. 2, the corebox for the skimmer being shown at *X* in the same illustration.

When the mold is made, the slag basin is rammed-up with the cope, being placed on the pattern-plate on the machine alongside the print for the runner. Its position is illustrated at *B* Fig. 4. As shown in Fig. 2, this basin is nothing more than a dry-sand cup 3 inches high and 2½ inches in diameter outside, with corresponding inside dimensions of 2⅝x1¾ inches. The lip of the basin, or what would be the rim of the cup, is notched as shown in Fig. 2. This notch is ⅞-inch high and ½-inch wide. It is set eccentrically and at such an angle that the metal entering the cup through the notch is given a whirling motion. The whirling basin is so placed in the cope mold that the entrance notch is opposite the lower end of the iron runner. The relative positions of the basin and runner are shown in Figs. 1 and 4.

The skim-gate proper is formed by two dry-sand slabs, one of which is blank while the other is perforated. The blank slab, shown at the right in Fig. 2 is set low in the drag and forms the base of the gate or metal channel. The perforated slab lies over it like a cover. These slabs are 3⅛ inches wide, 5 inches long and ½-inch thick. The perforated one has twelve ⅛-inch holes in the circular end and three rectangular holes, ⅛x½-inch, in the square end. When the gate is in use the metal enters through the former and exits through the latter holes. The position of the skim-gate in the drag is clearly shown at *S* Fig. 5.

When the mold is closed, the whirling basin in the cope shuts down over the twelve ⅛-inch holes in the skim-gate. The iron coming down the runner first enters the whirling basin through the notch previously prescribed and then plunges into the skim-gate through the ⅛-inch holes. While in the whirling basin it is given a circular motion and its velocity is temporarily arrested. This gives any particles of slag that may have come down the runner with the iron an opportunity to rise and separate from the metal. The small holes in the skim-gate facilitate this action. After entering the skim-gate the iron passes through it, where it is subjected to further skimming action, and finally escapes into the mold through the rectangular ⅛x½-inch holes previously described. By the time the metal enters the mold it is thoroughly cleaned and free from impurities, producing a sound casting.

The main central core is made on a bench in a metal corebox and dried in an iron dryer as shown in Fig. 3. This corebox is of the booking type. The core sand is mixed as follows: Four parts new Michigan City silica sand; four parts old molding sand, and eight parts yellow sand. In mixing, three quarts of glutrin and three quarts of oil are added to 24 shovelfuls of sand. The core is 15½ inches long over all and 4¼ inches in diameter at the largest section.

How the Main Core is Set

The main core is set in a large print in the drag as shown in Fig. 5. To test its concentricity, the gage shown at the right in this illustration is employed. The core must be absolutely on center. Furthermore, it must be prevented from shifting during pouring. To accomplish this, the small steady-core shown at *R* Fig. 5 is employed. This core slips over the upper end of the main core. It has a broad conical surface which is tucked in the sand in the top of the cope after the latter is closed over the drag. The upper end of the main core is thus firmly held in position. At the same time, the steady-

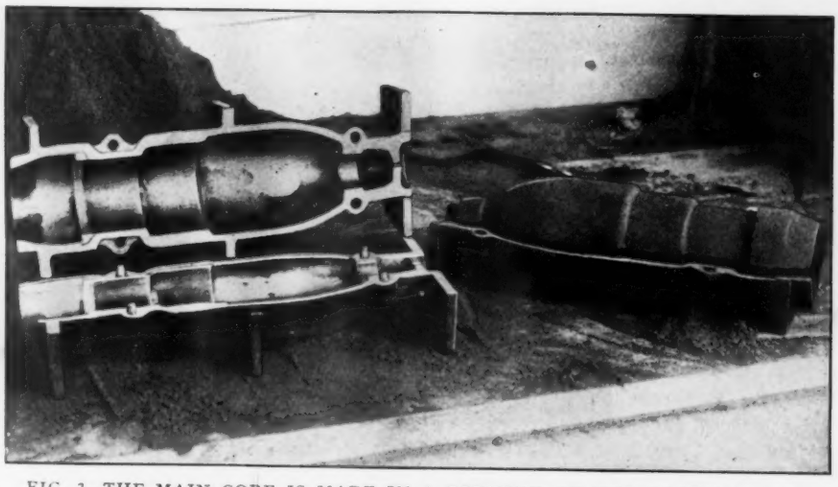


FIG. 3—THE MAIN CORE IS MADE IN A COREBOX OF THE BOOKING TYPE AND DRIED IN A CAST IRON DRYER

FIG. 4—A REAR VIEW OF THE MOLDING MACHINE SHOWING PATTERN READY TO RECEIVE COPE, WITH SLAG BASIN IN PLACE ON PATTERN PLATE

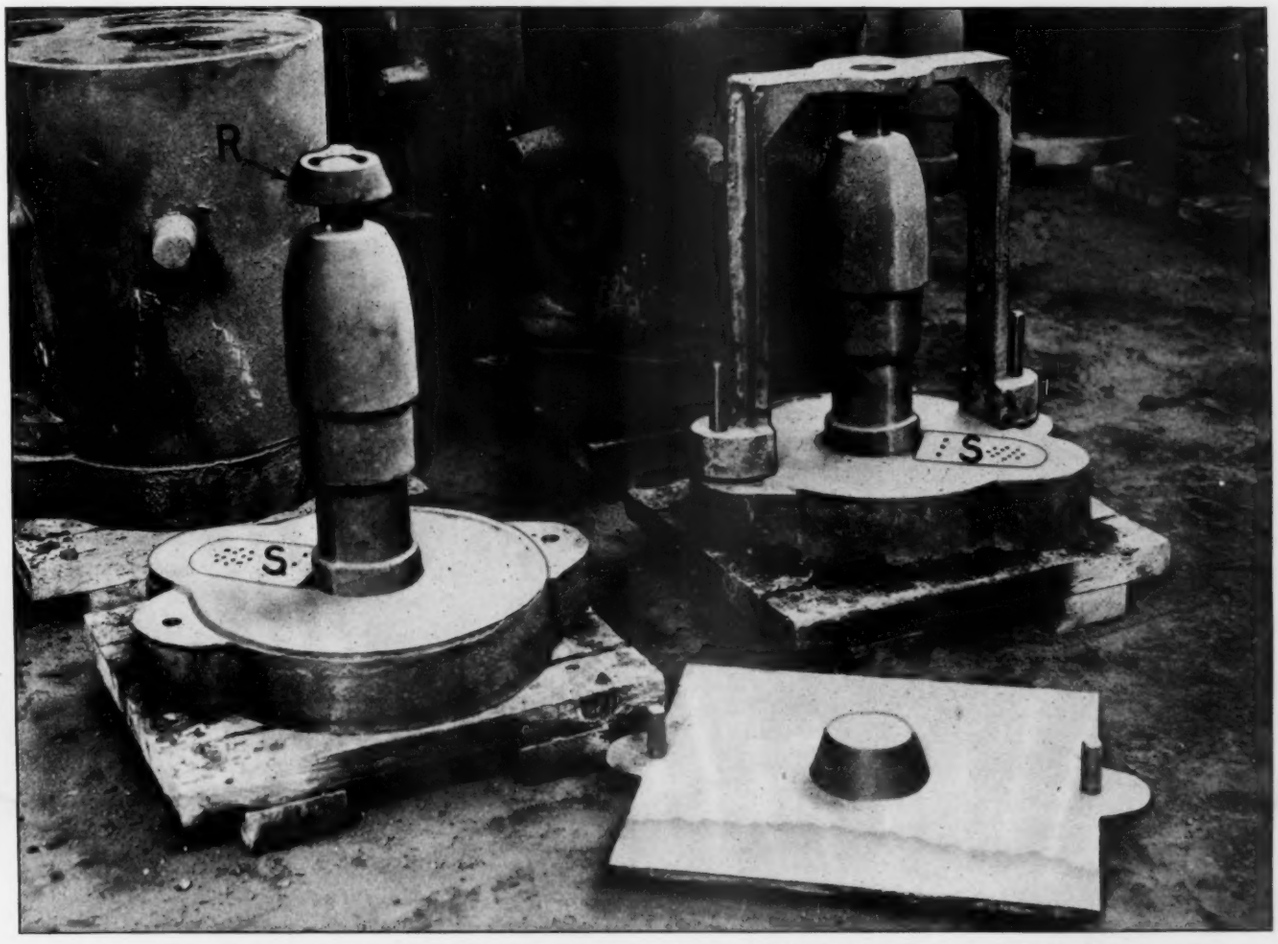


FIG. 5—THE MAIN CORES ARE TESTED FOR CONCENTRICITY BY THE GAGE SHOWN AT THE RIGHT. THE STEADY-CORE *R* HOLDS THE NOSE OF THE MAIN CORE IN POSITION

FIG. 6—HALF A DAY'S WORK. A FLOOR OF DUMMY-SHELL MOLDS WITH MOLDING MACHINE IN BACKGROUND

core forms a riser from the mold, being provided with two openings for this purpose.

The shells are poured with ordinary gray iron which is brought to the mold in a white hot condition. This iron contains from 2.40 to 2.45 per cent silicon and is a good stove-plate quality. At first some trouble was experienced from shrinkage at the nose of the shell. This has been eliminated by the use of the skim-gate previously described and by proper pouring practice. The mold is first poured until the metal shows flush with the top. Then follows a pause during which the metal is allowed to bubble and free itself from gas. Finally the pouring is resumed and continued until the small basin over the riser is brimming full. This practice is useful and insures sound castings.

Manufacturing Heavy Malleable Iron Castings

By A Walter Lorenz

MALLEABLE iron today is confined largely to the manufacture of comparatively light castings of thin section. Therefore, it may interest many foundrymen to learn that years ago the malleable process was applied successfully to the manufacture of castings which weighed several thousand pounds and were 6 or more inches thick. This metal had a tensile strength of from 50,000 to 80,000 pounds per square inch and could be machined as easily as low carbon steel. On the other hand, the resistance to wear was equal to that of high carbon steel. This metal was adapted to the production of gears, crankshafts, etc., and its exceedingly close grain made it desirable for use in casting valves and ammonia fittings.

This process was transplanted to this country about 50 years ago by a Scotchman named McHaffie. The method of making this metal was essentially the European whiteheart malleable process, but the secret of its production never was revealed by McHaffie to his coworkers. The manufacturers of this metal were not aware of the fact that the product was malleable iron, but they believed it to be a grade of semisteel and advertised it as such. The continuity of this manufacturing process was dependent upon the practical knowledge and skill of a few men and with the dissolution of this organization the production of this metal was discontinued. A few stray records still are available which cast some light on the manufacturing details and the author also has in his possession a few small pieces of metal from which the micrographs in Figs. 1 and 2 have been reproduced.

The pig iron used in the mixture was imported from England since repeated tests with American irons were unsuccessful. At the time when this plant was in operation, iron was graded by fracture only, which in large measure accounts for the failure to duplicate results with American irons. The following analyses of the different grades of English irons used in these mixtures were made subsequent to the dissolution of this organization:

	Total carbon, per cent	Silicon, per cent	Sulphur, per cent	Manganese, per cent	Phosphorus, per cent
Lorn	3.23	0.40	0.046	none	0.094
Bare mottled	3.49	1.09	0.389	none	0.046
Mottled	3.59	1.13	0.268	0.07	0.043
Dark mottled	3.84	0.89	0.216	0.09	0.040

The high sulphur content is one peculiar feature of the mixture employed since the castings were chilled by high sulphur rather than by low silicon. It is a question, therefore, whether the high sulphur content of European iron may not be one of the fundamental causes for the difference in the internal structure between

European and American malleable as claimed by a recent writer in THE FOUNDRY. While according to theory the whiteheart of European malleable is due to complete decarbonization, nevertheless, the analyses of many samples give this iron a carbon content of from 2.75 to 3 per cent. The analyses of the average cupola charges were about as follows:

	Per cent
Total carbon	3.45
Silicon	1.00
Sulphur	0.360
Manganese	0.06
Phosphorus	0.05

The silicon now would be considered somewhat high for heavy grades

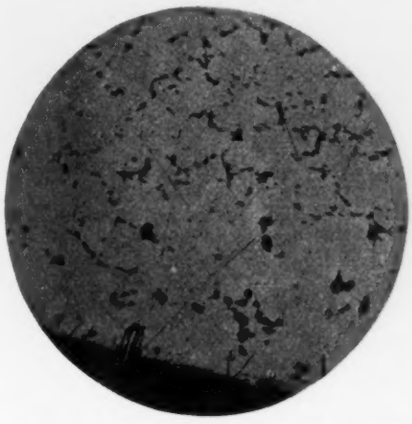


FIG. 1 — MICROGRAPH OF THE SURFACE OF A MALLEABLE IRON CASTING, 1½ INCHES THICK, WHICH SHOWS PRACTICALLY NO DECARBONIZATION
MAGNIFICATION 150 DIAMETERS

of work, but the high sulphur, of course, insured white hard castings. Notwithstanding the high sulphur content of the mixture, the molders evidently adapted their practice to conform to the high sulphur content and little trouble was experienced from checking. The castings made from the foregoing analyses had the following approximate composition:

	Per cent
Total carbon	3.45
Silicon	0.95
Sulphur	0.40
Manganese	trace
Phosphorus	0.05

The white hard castings were packed in roll scale for annealing and owing to the great variation in the sizes of the different pieces, great care had to be exercised in packing. Annealing pots were not employed and the smaller pieces were packed in the interstices of the larger ones and considerable skill was required to so place the castings that all would be uniformly annealed and would still not be bent out of shape. The castings were annealed for periods of from 10 days to two weeks, which included the time required for heating to the annealing temperature and cooling. After annealing, the castings had a white, steely fracture which extended throughout the castings of both large and small section. The writer has been informed that a casting 12 inches thick was annealed perfectly by this process. He was privileged to inspect castings 6 inches thick, which had a white section throughout and yet were comparatively soft to the core.

The micrographs shown in Figs. 1 and 2 are from castings 1½ inches thick. Notwithstanding the high combined carbon the metal was machined as easily as soft steel. Fig. 1 is a micrograph taken at the surface of this metal, which shows practically complete decarbonization. The magnification is 150 diameters. Fig. 2 was taken ⅜-inch from the surface which shows a mattrix of eutectoid steel including particles of graphite. The magnification is 150 diameters. The structure of Fig. 2 further is borne out by the following analysis:

	Per cent
Total carbon	2.71
Graphitic carbon	1.87
Combined carbon	0.84
Silicon	0.98
Sulphur	0.49
Manganese	0.02
Phosphorus	0.063

The shop men never differentiated between the fractures at the surface and at the center, which indicated that the structural changes must have been fairly uniform over the entire piece, the decarbonized area at the surface being so narrow as to escape detection.

As previously stated the tensile strength of this iron varied from 50,000 to 80,000 pounds per square inch and a test made in later years by E. F. Cone, of New York, placed the elastic limit at 35,000 pounds per square inch; ultimate strength, 70,000 pounds per square inch and elongation in 2 inches, 3 per cent. Two compression tests on 1 x 1 x 2-inch bars also were made by Riehle Bros., Philadelphia. The test pieces in each instance were subjected to the full load of the testing machine without breaking, but apparently they were at their ultimate limit. The ultimate strain of one test was 150,100, the specimen having been compressed to 1.54 inches and in the other test the ultimate strain was 146,600, the

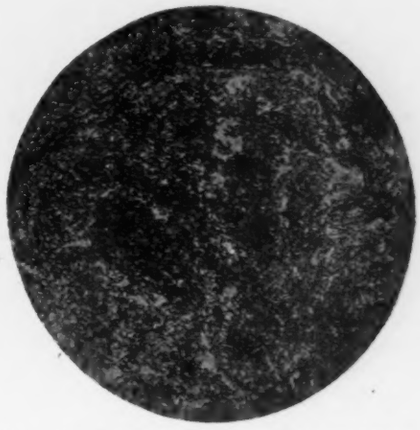


FIG. 2—MICROGRAPH TAKEN ⅜-INCH FROM THE SURFACE OF THE SAME SPECIMEN SHOWN IN FIG. 1
MAGNIFICATION 150 DIAMETERS

specimen having been compressed to 1.60 inches.

Undoubtedly there may be some difference of opinion as to whether or not this process produced well-annealed castings according to the present day definition of this term, but whether perfectly or imperfectly annealed, the resultant product had characteristics which made it desirable for certain classes of work such as gears, etc. Malleable iron foundrymen may find it advantageous to experiment with the production of larger castings as there are some applications of malleable iron where this product is equally as desirable as steel and the cost to the consumer will be much less, particularly at present.

Why the Inclined Mold is a Fallacy

By R R Clarke

THE practice of inclining a mold from 15 to 30 degrees from the horizontal for pouring, no doubt originated from the false hypothesis that metal will run faster by this added help of gravity than without it. The proposition admits an apparent degree of soundness in that metal, like any other liquid, will increase its rapidity of movement as it approaches the perpendicular of transit. This part of the proposition independently considered is stable enough, but taken as a premise to the better-casting-result conclusion it will be found sadly misleading when tried a few times. In the art of molding there is many a paradox, but none, we believe, more striking than that with which gravity and the hydrostatic principles have to do. It is an interesting procedure to analyze these paradoxes as applying to our daily molding experiences and to note the fidelity of principle and the

perfect coincidence of casting consequence with it. If any molder or foundry foreman will note the behavior of water, he will have an almost absolute criterion to the action of liquid metal in pouring and coming to rest and derive much practical benefit from the observation. He might profitably observe the difference in pressure of the water flowing from the spigot in the cellar and that from a spigot on the third or fourth floor; the variable effect of pouring water from different heights on a flat surface and pouring it from the same variables of height into a pool; the greater depression on the bottom of a dish-pan filled with water and suspended in the air and that in a tin can filled to the same height; the rapidity with which water will drop in a bent tube and rise to its level; the effect of elevating the pouring end of the tube; the uniformity of time observed by water and oil in dropping and rising the same distance; the partitioning variation between forcing water over a flat, level surface and forcing it down an inclined plane; the voluminous and rapid discharge of water from the horizontal arm of a 90-degree angle pipe deriving its pressure from height, no matter to what length that horizontal arm be extended. These, and many other observations he might profitably take and thoughtfully consider.

A Relic of the Past

The inclined mold in different foundries remains today a relic of a preconceived misunderstanding, perpetuated by custom or precedent. It surely is time that the fuse be lit that the fallacy might explode. In any liquid, molecules observe free state and cohesion is practically lacking. They consequently separate with greatest ease and upon slightest provocation. Liquid metal, therefore, will not hang together properly in coursing down an inclined plane under the turbulent effect of the fall in the pouring gate and the variable supply of metal that source is often permitted to yield. Liquid metal derives its pressure, supply and rapidity of movement from vertical height in the sprue and transmits this pressure free and undiminished to all parts of the mold in ratio to height above any point in the mold. Liquid metal will float much of its dross and impurities and when backed up in the sprue, traps these impurities exempting the casting therefrom. Gravity's maximum effect is perpendicularly downward. Weights placed on an inclined flask do not produce a holding down effect identical with the horizontal position. Natural shrinkage in a casting is in line with gravity, as is also feeding of congealing metal. The highest point in mold metal always shrinks most, other things being equal, and exercises a feeding function to the metal beneath it. A liquid entering an inclined enclosure delicately balanced will destroy that balance and result in a swing to the perpendicular.

These are mainly the principles which the following actual foundry conditions will explain: Long, thin, yellow brass strips poured in elevated molds were frequently found to contain mis-run sections in different parts. The first metal striking the bottom of the pouring gate had leaped down the runner gate and failed to unite with that following.

Mis-Run Section Burned-In

These mis-run sections had to be burned-in to save the casting. Twelve thin rings, six on either side of a runner to which they were attached were poured in an inclined mold from fairly cold metal. Two at the upper end and one near the middle failed to run. From the same metal an identical mold was poured immediately afterward and only one ring failed to materialize. When you pour a mold with the pouring end elevated, if the upper castings get sufficient pressure, the lower ones get too much; if the lower castings get enough pressure, the upper are invariably without sufficient pressure. The probable consequence is that either the one will shrink, or the other swell. Of two different foundries in which we have worked one cast journal bearings on the incline, the other on the level. In the latter foundry, we seldom if ever noticed a shrunken or badly swelled journal bearing. In the other we have seen the most extreme cases of both.

In pouring a mold, the best practice is to pour hard enough to keep the sprue well filled during the entire process. This is a preventative to dross getting into the runner gates and castings, as well as a strong influence toward rapid and compact movement of metal into these castings. But it is difficult to accomplish this in the inclined mold, unless the gates be of the *choking* type, which is not the best of gating practice. In inclined molds, freely gated, the metal is seldom seen in the sprue until pouring is completed; in those poured on the level, it is no uncommon sight. Dross or charcoal passing the skimmer in the inclined mold, most likely will locate in the runners or the castings, while in the level mold it will ride the surface of the metal in the sprue and will do no harm. That these things actually occur we have positive proof and it has long been a subject of wonder to us that those foundries that continually lose castings because of these implied defects, will so tenaciously cling to the very practice in which those defects originate. Surely such practice can well give way to other methods and at least can do no worse. But custom is king over more than one foundry. When you weight down a level mold securely, you have the full power of creed and custom is king over more gravity to guarantee it immunity to a run-out. This power you have uniformly distributed. But this is not so in the inclined mold. The greater effect there, is at the lower end of the flask and acts as a helping leverage to the lifting power of the metal at the front of the flask or pouring end. How often we have seen flasks thus poured lift and run out at the pouring end is a matter of monotony. Many consequences, of course, are invited. The swelled casting, the mis-run portions, the out-of-center core, the ruined flask, accidental injury to workmen, etc. These are big items in the business of modern founding and surely are worth that argumentative force that their logic and plain common sense imply.

Good pouring practice generally starts a mold carefully and slowly until the buttons are filled and then increases to gate capacity until the mold is nearly filled, when the stream is perceptibly reduced to avoid straining the casting. But the end of pouring must not be too slow. In pouring a level mold, it is not difficult to come to the head of the sprue, conservatively shut off the stream quickly and spill no metal. You can scarcely do that in the mold of much inclination. The metal comes to the surface of the sprue, runs down over the flask and mold and spills all over the floor. We have often seen the man doing the skimming, look down to see whether the metal running down the mold's side was coming from a run-out at the back end of the flask or merely an overflow from the sprue.

Heavy Metal Losses Incurred

Not long ago, we saw a machine molder start to pour the second row of a tier of snap flask molds. About half-way down the line he struck a mold delicately balanced on the mold beneath. The first entering metal turned the trick and the flask toppled over. This tier of molds rested on an angle iron bench, inclined about 20 degrees from the horizontal. If you want to find heavy loss of metal and huge quantities of daily foundry spillings, go into those foundries observing mold-inclining and you will most probably find what you are looking for.

Just one more consideration. Do you know the difference between closing a heavy cope on a drag setting in a horizontal and another in an inclined position? Well, if you do not, we can assure you that the distinction is all in favor of the former, especially if the cope contains deep sand projections requiring a straight, level and accurate lowering onto the drag.

Preparation of Metal Parts for Electro-Plating---II

The Importance of Buffing and Cleaning and How These Operations May be Carried On Economically and to the Best Advantage

By E P Later

IN THE preceding article some of the methods and materials employed in polishing metal parts prior to subsequent finishing operations were discussed and the process of buffing and cleaning now will be considered briefly. Before going further, however, it may be noted that whereas thorough cleaning is absolutely necessary prior to plating, buffing, in the case of certain parts, may be omitted both before and after plating. For example, when plating is done solely for the purpose of protection from corrosion rather than for the purpose of ornamentation, it may be neither necessary nor desirable to include a buffing operation. With parts which must be given a high-grade finish the surface left by the last polishing wheel, however, is unsatisfactory from an appearance standpoint and recourse must be had to buffing for the production of a mirror-like finish which is entirely free from visible scratches and blemishes. Whether or not the nickel or other deposited coating need then be buffed depends on the requirements of the finish; in many cases it will be found that the coating, particularly if it is rather thin, is bright enough without buffing and the cost of this operation may just as well be saved. It always pays to consider questions of this kind carefully, when specifying the finish for different parts, inasmuch as it is often possible to cheapen the cost of production through the elimination of unnecessary operations. Of course, if the deposit is heavy or the highest grade of finish is desired, it will be necessary to buff the parts after plating.

Buffing Defined.

Buffing is ordinarily defined as *cutting down* and *coloring*, depending on the effect produced. As the name of the former indicates, a small amount of metal is removed, or at any rate slight irregularities of the surface are smoothed out, leaving it smooth, but without a high luster; in coloring, the surface is further rubbed down and the very fine marks left by the preceding operation removed, fine abrasives being employed, with the production of a mirror-like finish.

Several different types of buffing wheels are in ordinary use. What is known as sewed buffs are made of a large number of cuttings or small pieces of muslin, either bleached or unbleached, according to the requirements. In a well-made buff care is exercised to see that these pieces are laid at different angles in a form of the required size. It is also important that the edges of the pieces do not overlap or that seams or ridges be produced; they are flanked on each side by full-sized blanks and when a wheel of the desired thickness has been built-up it is sewed tightly together starting at the outer edge and proceeding in a circular manner to the hole in the center, or *vice versa*. As might be supposed, buffing wheels made in this manner are fairly hard and are used for heavy buffing and cutting down.

Material Used for Buffs

Loose buffs are made from full-sized blanks of muslin, either bleached or unbleached, and sewed merely around the hole. Buffs made in this way are softer and more flexible than a full-sewed buff; for certain kinds of work the latter are desired, but in such cases they are sewed from hole to circumference.

Canton flannel buffs, usually made of 18 sheets or layers of cloth and sewed only around the hole, are quite soft and fluffy. They are used largely for coloring jewelry, silverware and fine work generally.

A buffing compound of some kind is ordinarily applied to the face of the wheel before bringing the work into contact with it. The mode of application is different, however, from that employed in the case of polishing wheels, which consists in gluing the abrasive to the wheel. Buffing compounds comprise some fine abrasive worked into stearic acid or similar substance so as to form a comparatively hard cake or stick. When this is held against the rapidly turning face of the buffing wheel sufficient friction and heat are generated to remove a portion of the compound which is forced into the surface and adheres quite strongly.

Concerning the abrasives used not much need be said. Crocus, rouge and tripoli are familiar names to every plater; the first two are oxides of iron, produced by heating certain iron salts to a high temperature, after which the resulting product is given other appropriate treatment. Tripoli is a term which is used rather loosely to denote polishing media of a silicious nature. The kind of material to be used depends on the metal which will be buffed; what will give satisfactory results with one metal will not always do so with another and for this reason suppliers usually recommend a particular brand of their product for certain purposes. However, it is often necessary, and will ordinarily be worth while to experiment with different brands, until the one is found which gives the best results, all things considered.

In any event it is always economy to get good, not necessarily the most expensive, but honest and reliable, materials of any sort and this applies as much to buffing compositions as to anything else. The manufacture of these requires some care and attention; the polishing medium must be properly prepared and graded, for coarse or gritty particles will cause most unsightly scratches and marks. Then, too, unless the vehicle is of such a nature as to permit of easy and thorough removal by the ordinary cleaning processes, after buffing, trouble is liable to develop.

Speed of Operating Buffing Wheels

As is the case with polishing wheels, the speed at which buffing wheels are run is an important factor in the production of work of the desired quality at the least cost. In the preceding article the matter of spindle speeds was gone into at some length and a few examples given of the way in which the peripheral speed of wheels may be calculated. It will not be necessary to repeat this here, for the principles are exactly the same, but it should be noted that the speed of buffing wheels should be somewhat higher than that of polishing wheels, say from 8000 to 10,000 feet a minute.

The necessity of thorough cleaning was mentioned at the beginning of this article and it can hardly be emphasized too strongly that the surface of the parts must be made perfectly clean and free from all grease, or the coating will not adhere. As they are received in the plating room, the parts may be covered with rust or scale, with grease or other foreign matter, or more or less badly tarnished; it is necessary then to remove these various coatings and put the surface in proper condition for what-

ever subsequent finishing operations may be required. Cleaning is neither easy nor a task of small magnitude and while this subject can not be adequately treated in the space at my disposal, a *resume* of some of the more important points may be helpful.

Rust and scale are usually removed from iron and steel parts by immersion in dilute sulphuric, hydrochloric or muriatic acid and this method gives very good results although certain facts in regard to it should be kept in mind. Rust is ordinarily easily enough removed, but scale, hard and dense oxide of iron, often adheres most tenaciously and considerable time and trouble may be required to get rid of it. Allowing the parts to remain in the acid for a long time, of course, will eventually take all of it off, but such treatment is not very desirable; the portions which are not covered with scale are attacked readily by the acid and a comparatively large amount of iron may thus be removed, often with the production of a rough and seamed surface. This is not only objectionable in itself, but it occasions the waste of a large amount of acid, which is not only expensive, but hard to get at the present time. Furthermore, excessive pickling in acid is distinctly bad for iron or steel, in that such materials are thereby rendered much more susceptible to corrosion; this is probably due to the formation of an hydrogen-iron alloy. A decided hardening and increase in brittleness is also produced, which is particularly noticeable in the case of small springs and similar articles; when prepared and plated in the ordinary way these may be so brittle as to be worthless.

Sandblasting Parts Recommended

When iron parts are to be plated the increased liability to corrosion induced by pickling does not seem to be of so much consequence, but for cleaning preparatory to japanning, it is not to be recommended. Fortunately, sandblasting offers a very good means of producing a perfectly clean surface and the plater will do well to investigate its possibilities. Advances of considerable importance have been made in this process during the past few years and it has been brought to a high state of efficiency and effectiveness, to say nothing of the many improvements, in the way of eliminating dust, for example, which have made it safer and more pleasant for the workmen. Large pieces may have to be handled individually, but many small parts can be well and quickly treated in sandblast barrels. As the name indicates, these are a sort of barrel-shaped arrangement into which the parts are placed and then, while the barrel revolves slowly and tumbles them around, exposing all of the surfaces, they are subjected to a blast of air and sand or other abrasive and thus thoroughly cleaned in a short time. One of the good types consists of two barrels, one inside of the other; the inner barrel holds the parts and has numerous perforations in the sides through which the spent sand passes, collecting in little pockets of the outer barrel; as this revolves the sand is carried up and deposited in a hopper, to be used over again.

Abrasives Used

Perhaps a word about some of the abrasives used may not be out of place. Sand has been employed more widely and for a longer time than anything else and if it is of the proper quality and rightly handled it gives good results. It should, however, be hard, sharp and clean; if the grains are too much rounded or if any considerable amount of clay or other foreign material be present, the abrasive qualities of the sand, and consequently its effectiveness, are seriously reduced. For this reason as complete a seperattion as possible of the good sand from the dust and dirt which, after use, necessarily is mixed with it, is an important item in the successful operation of a sandblast outfit.

In many establishments ordinary sand has been replaced more or less completely by diamond grit, chilled shot or some other material. Diamond grit is crushed steel, possessing sharp cutting edges and great hardness. It has the advantage over sand that it does not break-up and dust like the other. Chilled shot is very hard and possesses many of the advantages of the grit, but it is round rather than angular, hence its actual cutting qualities are lower. For this reason it tends to give the surface of the work a shiny appearance by reason of the peaning, rather than cutting, effect.

In case acid is used, however, it is highly desirable that the parts be kept in the acid no longer than is necessary to accomplish the requisite cleaning. To this end care must be exercised to see that they are not crowded together in such a way that large areas of the surface are in contact and thus more or less effectually protected from the action of the acid, with the result that longer immersion is required. It is also advisable to chip off as much as possible of the heavy scale, both before and during the pickling.

Removing Sand from Castings

Sand may be removed from castings by the use of a dilute solution of hydrofluoric acid. Fortunately, this acid, while it very readily attacks and dissolves sand or silicious material, does not affect the iron very seriously and comparatively little of this goes into solution. Sometimes a small amount of hydrochloric acid is added to hasten the action; a mixture which has been found to give good results is composed of hydrofluoric acid, 30 per cent, six parts; hydrochloric acid, 2½ parts; water, 40 parts. Warming the acid is also conducive to quicker action, but a high temperature must be avoided. Incidentally, the fumes arising from this acid are poisonous and should not be inhaled. It should, of course, be kept in a wooden or lead tank, instead of an earthenware jar, which is often used as a container for other acids.

Oil and grease are ordinarily present on the parts sent to the plating room and these must be removed before finishing. If the grease is of animal or vegetable origin the simplest and easiest way of freeing the surface of it is to immerse the parts in a strong solution of alkali; in practice caustic soda, a mixture of sodium hydroxide and carbonate, or some such material is usually employed. The solution is used at the boiling point and under these conditions the fat is broken up chemically with the production of glycerine and a sodium soap, which is a compound of the metal sodium with the organic acid radical of the fat. Both of these products are soluble in water, the glycerine particularly so, so that we have in effect transformed the original fat, insoluble in hot or cold water, into two new substances both of which are soluble.

Heat Quickens the Process

Inasmuch as the action is very largely chemical the thought at once suggests itself that the process can be hastened by the application of heat, and such is the case; the cleaning solution should be kept very close to the boiling temperature, if the best results are to be obtained. Again, since the cleaning agent, the alkali, is actually used up and removed during the process, as far as further cleaning is concerned, it follows that fresh material should be added from time to time.

Agitation of the parts while they are in the solution is of assistance because it tends to remove more thoroughly the film of soap and glycerine which tends to cling to the surface; it is sometimes necessary, or advisable, to remove them occasionally from the tank and brush them off or dip them into clean, boiling water. Finally, it is evident that this method of cleaning is applicable only in the case of metals which are not attacked by strong alkalis, such as iron, brass, bronze, copper and so on. Aluminum, zinc and some other metals and alloys containing them are dissolved by alkalis, consequently any attempts to clean in this manner, parts made from them should be cautiously conducted, otherwise the metal may be dissolved to such an extent as to ruin the part.

Gasoline may be used to advantage in

cleaning work of this nature, quickly and without danger of injury. It should be remembered that when the gasoline evaporates it leaves a thin, greasy film on the surface, so this must also be removed and perhaps the simplest way of doing it is to scour with whiting and water, afterward rinsing off well in clean water.

In recent years the removal of grease and dirt by the aid of the electric current has become rather general and this process has much to recommend it. There are several compounds on the market designed for this use; they are essentially alkaline substances and are used in water solution. The alkali presumably helps to remove the grease, but in the main the action is brought about by the current; the parts to be cleaned may be made either the anode or cathode, usually the latter, and when a strong current is passed through the tank large quantities of gas are evolved from the surface of the work and this effectively strips loose whatever foreign matter is present.

A cleaner of this kind is not difficult to construct and will be found to be very useful. The tank is best made of steel or iron and should be provided with steam coils to heat the solution to somewhere near the boiling point. The tank itself may be used as one pole, the work forming the other; or sheet iron plates may be employed.

Removing the Coating

Frequently parts to be finished are covered with vaseline or some heavy mineral oil, when they come to the finishing room. Oil and grease of this nature differ considerably from those of animal or vegetable origin, but the fact which concerns the plater most is that they are not attacked chemically by alkaline solutions and their removal may, therefore, present some difficulty if the ordinary methods of procedure are employed; although the regular cleaning solution may remove a portion by emulsifying it, it is usually necessary to employ other means of getting rid of all of it. In such cases recourse is had to some solvent solution and gasoline is frequently employed; this simply dissolves the oil or grease and leaves the surface clean with the exception of a thin film of oil, which may then be removed by scouring with whiting and water, by the electric cleaner or by a quick dip in acid. Of course, the use of gasoline presents a certain fire-hazard, and in order to obviate this it is the practice in some places to add carbon tetrachloride, say up to 50 per cent. to the gasoline.

The removal, from highly buffed surfaces, of the grease left by the buffing composition must be done with some care, otherwise the surface may be damaged. If an alkaline cleaning solution is used the immersion should be as short as possible in order to prevent etching or marking. Scouring with whiting and water is often employed as a means of removing the last traces of grease and a dip in cyanide is resorted to for the removal of the slight tarnish which is almost always present after immersion in the cleaning solution.

Cleaning Brass and Copper

Brass and copper usually are cleaned, after the grease has been taken off, by giving a bright acid dip. This is usually a mixture of nitric and sulphuric acids, the exact proportion in which the acids are mixed varying somewhat with different platers; one formula which works very well calls for nitric acid, 6 parts and sulphuric acid, 2 parts. To a crock of this mixture many workmen add a handful or so, of common salt. Heavy scale or oxide on the surface of copper or brass is frequently removed by a sulphuric acid pickle; in some establishments a mixture of equal parts of nitric and hydrochloric acids is employed, particularly for use on parts in which iron and brass are assembled together.

After an acid dipping or pickling operation, the parts should be thoroughly rinsed in clean water so as to remove all of the acid; then it is the usual practice to dip the parts in a cyanide solution, to remove whatever acid and water stains are present. After thorough rinsing in cold water and dipping for a few moment into boiling hot water, the parts are ready for drying in sawdust, or otherwise.

The methods outlined are satisfactory enough as far as results are concerned and have been in use for many years, indeed, they are about the only mode of treatment available thus far for certain classes of parts. A considerable amount of handling and the use of a good deal of acid, is however, involved in their application and more attention is being paid to other processes which, although not new, have heretofore perhaps not received the consideration they merit. The great game at the present time is to get along with less men and materials. Labor is far from plentiful and many things, acids especially, are scarce and costly. Nitric and sulphuric acids are absolutely indispensable in the production of necessary munitions of war; nitric acid, for example, is the basis of all explosives now used. Whoever cuts down his consumption of some of these materials is not only doing a patriotic service, but he is likely to find that, for him, it is a profitable enterprise as well.

Cleaning by Tumbling Process

For the finishing of parts whose size, shape and general character is of such nature as to permit of their treatment in tumbling barrels this method offers many advantages; it is possible in many instances to take the parts as they are received and prepare them for plating, clean, with polished surfaces and all, entirely in this manner.

Castings and other parts which are more or less rough can be tumbled with ordinary sand and water containing a small amount of alkaline cleaning compound. In order that the best results may be obtained the sand should be hard, sharp and clean. After the parts have been cut down and smoothed off to the desired degree, the sand may be washed out of the barrel and, if necessary, the tumbling may be repeated using ground flint or pumice or some such material; this treatment should leave the parts smooth, but without luster. It should be understood, however, that with some parts the first or even both of these operations may be omitted; the condition of the surface as received and the final finish desired are usually the deciding factors.

For the production of a high luster, rendering buffing unnecessary, the parts may now be treated in the barrel either by the wet or the dry process. In the former, the parts are placed in the barrel along with anywhere from 100 to 300 pounds of steel balls, the size of which will depend on conditions; it is often desirable to mix the larger and smaller sizes together. Some sort of lubricant is needed and for this purpose soapy water is frequently used. Under the rubbing and pressure which the parts receive as they are tumbled about in the barrel, the surface soon acquires a very good luster.

Cleaning by the Dry Process

In the dry process, leather meal or similar material is mixed with some fine abrasive, such as crocus or rouge, and placed in the barrel along with the parts to be polished and the whole mass rotated until a satisfactory luster is produced.

In place of buffing after plating, the tumbling barrel may be again employed, using either the wet or the dry process described, but whereas preparation of the surface before plating may necessitate tumbling for a number of hours, the polishing of the plated deposit will be accomplished very much quicker.

Tumbling barrels may be had in various sizes and shapes from a number of manufacturers, any of whom will doubtless be glad to furnish whatever information may be desired.

The horizontal type of barrel is particularly adapted to heavy or bulky work and may be used for either the wet or dry method of polishing. Oblique barrels, running on an inclined axis, are usually made so that they can be tilted, thus facilitating discharge of the contents; examination of the work from time to time, is also easier in this type.

Welding Propellers in Panama Canal Foundry

How Blades Are Repaired by Burning-On, With a Comparison of Costs With Autogenous Processes—Making the Molds and Pouring the Metal

By John H Moffett

THE application of electric and oxy-acetylene welding has made rapid advance in a wide and diversified field. These processes rendered invaluable service to the nation in a time of trial, when by their application the damaged engines and machinery of the 109 German ships seized by the United States government were repaired months ahead of any estimate for repair or replacement. Yet, with no attempt to discredit the unquestioned utility of these two methods of autogonous welding, there are jobs on which the old foundry method of welding, burning, as it is termed in foundry parlance, is able, under favorable circumstances, to compete successfully with them, both as to cost and efficiency.

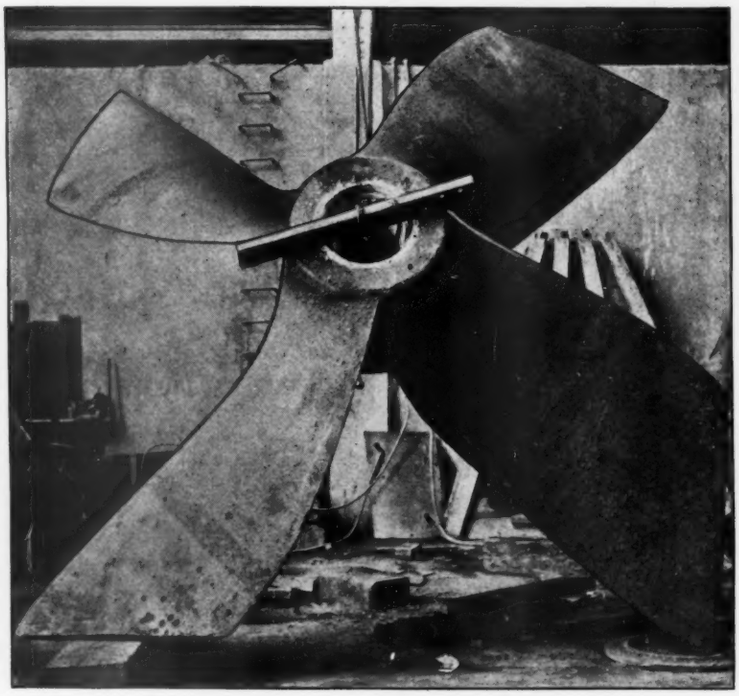


FIG. 1—PROPELLER WITH DEFECTIVE ENDS OF BLADES CUT OFF, TO BE REPAIRED BY THE BURNING-ON PROCESS

Several of these jobs have been completed recently, by the foundry of the Mechanical Division of the Panama Canal, effecting a great saving to ship owners. The work was done on both broken and deteriorated propeller blades. To replace some of the propellers with a new casting would have cost ten or more times the expense of welding in the foundry. In fact, the cost of freight and casting for a propeller brought from San Francisco was $1950, while the cost by the foundry method on some of the propellers ran as low as $90, and in no case higher than $125. The lowest estimate of the welding plant, which has extensive and modern equipment in both electric and gas outfits, was $350. At the very outset the welding plant was handicapped by requiring castings for patches. Of course, to the expense of the castings was to be added the additional cost of patterns; whereas the foundry needed no patterns except the discarded ends of the propeller blades. The blades of the first propeller welded were broken accidentally when the cable-sling, by which it was being hoisted, parted and dropped the casting on the curbing of the dry dock where the ship from which it was being removed was lying. The ends of the blades were broken in several pieces; furthermore, some of the pieces were lost. Patterns and castings had to be made so that the welding shop could handle the job. Even then it was doubtful whether the possibility of cracking, due to so many welds running at divergent angles to one another, could have been overcome. The Mecanical Division was responsible for the propeller and had to replace it with a new one or repair it satisfactorily. The superintendent of the division, after getting the lowest estimate of $350 from the welding shop, decided to consult the foundry officials to ascertain whether or not the job could be completed at a lower cost. The foundry placed an estimate of $150 on the work, and completed it $50 under the estimate. This gave such

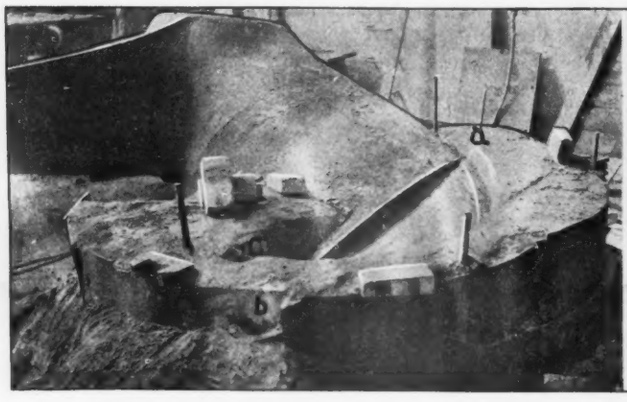


FIG. 2—DRAG PART OF THE MOLD, SHOWING ONE OF THE BLADES TO BE REPAIRED

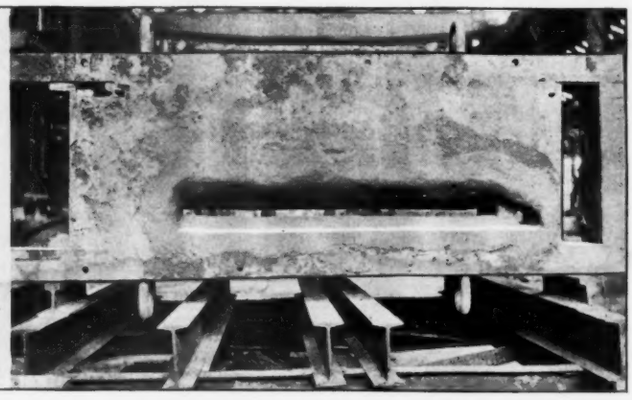


FIG. 3—THE TOP SIDE OF THE COPE, SHOWING THE LARGE WEDGE GATE

FIG. 4—COPE HALF OF MOLD FOR BURNING-ON BROKEN PROPELLER BLADES

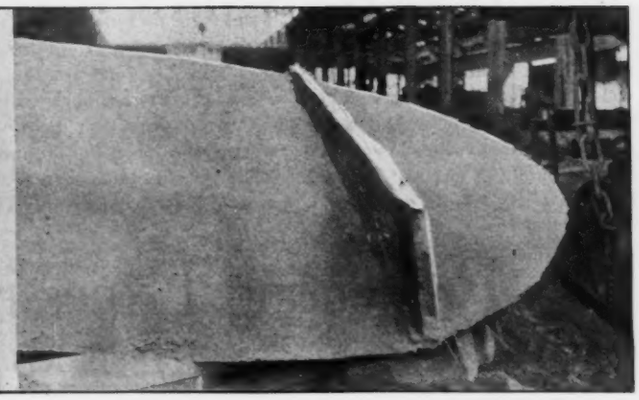


FIG. 5—ONE OF THE BLADES WITH NEWLY BURNT-ON END, AS SHAKEN-OUT

satisfaction as to cost and workmanship that when the ship owner heard of it, the spare propeller was sent in for repair while the big vessel went on its voyage to stop on its return trip for the spare.

The ends of the blades of the spare propeller were honeycombed and eaten away by the galvanic action of the sea water. Apparently, the churning action of the blades comingles the air and salt water to such an extent that the galvanic action set up finally eats away the ends of the blades or otherwise honeycombs them until the force of propulsion is lowered so much that it is poor economy to set the cost of renewal against the loss in speed and efficiency. Old seamen say that tropical waters are more effective in attacking the blades than those of northern latitudes and that, although the time varies with several factors, eight to 10 years is the average life of cast iron propeller blades. The propeller, after cutting off the deteriorated ends of the blades, is shown in Fig. 1. The ends were cut so that all honeycombed portions were eliminated. The cutting was done with pneumatic tools and in places the recess was cut entirely through the blade to permit steel wedges to be driven in. This method provided the molder with the rejected ends as practically intact patterns.

The drag portion of the mold with its curbing of sheet steel, is shown in Fig. 2. It will be noted that the fractured end of the blade has been channelled the entire length to facilitate fusion and knitting when the molten iron is poured along the edge after the cope has been placed over it. Fire brick were rammed in place under the break to protect it from the cutting action of the metal, which was poured from a considerable height. The mold was rammed in dry sand and closely nailed to withstand the washing action of the 3000 pounds of metal poured through it. At *a*, *b* and *c* bleeders, 1 inch in diameter, were placed to flow-off the excess metal. During the first stages of the pouring, *b* and *c* ran simultaneously. After about one-third of the metal had been used, *b* was closed with a bot of clay; then another third was run through *c* which was then closed to allow the remainder to go up through the cope and run out through the channel at *a*. These operations insured the removal of any dead metal which lay at the thin edges of the weld. The bleeder *a* was run up through the cope to give head to the metal remaining in the gate at the end of the pouring.

FIG. 6—PROPELLER SHOWN IN FIG. 1 WITH ENDS WELDED BY THE BURNING-ON PROCESS

In ramming the drag the end of the propeller blade broken off was advantageously used for a pattern. The missing portions were formed with sand which was removed when the mold was dressed. Here is where the foundry saved the expense which was the first consideration in the welding plant. Fig. 2 shows the mold with broken ends and the formed sand removed to give the impression for the blade and after the cope was lifted off. The top side of the cope is illustrated in Fig. 3. The long, narrow slit or wedge gate fits exactly over the broken end of the blade. At the right end will be noted the overflow designated as *a*, Fig. 2. The under side of the cope is clearly shown in Fig. 4. One of the blades with its newly welded end and the gate before being chipped off is illustrated in Fig. 5. Some of the bricks placed in the drag under the break are seen clinging to the casting. The completed propeller is shown in Fig. 6. The new ends of the blades and the distinct markings left by the chipped-off gates are outlined.

The actual welding operation was accomplished by swinging a 3000-pound ladle of metal to and fro while pouring the stream into the long wedge gate, shown in Fig. 3. Care was taken to pour the major portion on the high edge of the propeller, which was not lying exactly level because leveling pre-

sented a very difficult task with such an unweildy casting. The highest point was at *c*, Fig. 2. Under these conditions the operation as outlined insured welding of the high edge. There was a tendency toward poor knitting while the metal flowed to the lower edge when the opening at *b* was in use. The bleeder *b* was used primarily to prevent this as much as possible, for by closing it, the metal was forced by the higher edge.

The end of the blade was preheated for two hours with an oil-torch before closing the mold, and the portion of the propeller immediately back of the weld was heated for about the same length of time after pouring. This helped to prevent cracking, none of which was experienced. Four propellers have been repaired by this process for different steamships. All propellers were about the same size. The largest was 20 feet in diameter; the blades were 48 inches broad, and some welded sections of the blades were 3 inches thick, reflecting the advantages of burning.

Preventing Excessive Labor Turnover

By A H Williams

LABOR turnover represents that part of labor which constantly is being hired to replace defections from the regular ranks of workpeople. Generally it is measured in per cent of the number of men required for a stated period. Labor turnover is an important factor of all industrial operations, particularly at this time, and few realize its importance; the loss cannot be gaged accurately in dollars and cents and may be estimated by comparison only. Therefore, I will briefly outline some of its effects and point out remedies having a tendency to reduce it.

There are many reasons for the increased rate of turnover. Among these, the scarcity of labor is of ranking importance. Many men leave their places of employment if working conditions are unsatisfactory. Others, formerly steady workers, induced by the promise of larger returns for their labor, join them in the procession. Another cause is the opinion held by the employes of some companies, notably those working on war orders, that the management, stockholders, etc., are reaping great profits on their product, while they receive only a small increased wage for their added labor and increased production. In many cases the management is at fault. Frequently it will be found that some men are making two and three times as much as their companions, for no other reasons than that they have a task upon which a piecework rate has been set that is out of all proportion to the value of the task. As a result, the men so favored, who can earn several days' wages in one, will lay down on the job and cut production through fear of having the piecework price reduced.

A lack of uniformity in wage advances throughout the country is another cause for the shifting of labor today. The indifference of some employers in not meeting conditions squarely and getting the co-operation of their men is another cause for this increased turnover. Men cannot be handled, hired or fired as formerly and if this condition is not met half way, no degree of success can be attained in keeping or improving an organization. Many vacancies are caused by enlistments and the draft, but these alone will scarcely impair the efficiency of an organization if the proper steps are taken to avoid it.

The effect of this labor unrest is injurious to any plant organization, especially if it has attained a high state of efficiency. New men mean poor work and spoiled material, high labor cost with low production, which will extend over the period of their apprenticeship. In times like these when our very existence depends upon maximum output, it cannot be said that any company is doing its patriotic duty unless it is offering suitable inducements to hold its experienced labor. Men skilled in one shop do not necessarily become skilled laborers in every shop and invariably a trained man is more valuable to his own than any other company, unless called by the government. Care should be exercised to retain office help, although the percentage of turnover is not so great among this class as those employed in the shops.

Several remedies may be resorted to, to reduce this inflated percentage of turnover, the success of which depends largely upon the care exercised in their application. An employment department is almost indispensable for a plant of any size; if it is properly administered, it can do much to keep the men satisfied, to employ the right class of men and to keep undesirables out. By maintaining an employment record, this department will be in position to fill vacancies and to furnish data pertaining to employment, wages, turnover, etc. Welfare work should be in charge of the employment department and it should supervise the transfer of men from one department to another, adjust labor rates, devise and operate bonus systems, etc.

Profit-sharing has been introduced in many foundries in the east and has been found to be a satisfactory method for holding an organization together. One system provides for paying the men a percentage in excess of their earnings, based upon the production for the period of the pay as compared with past averages. This plan has a tendency to make the employes themselves weed out the shirkers, as their dividends are directly dependent upon the output of all of the men in the plant. The author had the good fortune to note the operation of this system in practice in a large eastern foundry employing foreign speaking laborers and molders exclusively. The results were beneficial and resulted in greatly reducing the labor turnover, with a proportionate increase in production. Operating by this system wages tend to remain uniform and when the period of wage inflation is past, the dividends may be reduced or wholly abandoned, if such a course should seem advisable.

Hardening Surfaces of Steel Castings

A recently patented method of making steel castings with hardened faces consists of making the part of the mold adjacent to the section of the casting to be hardened, of some material which, under the influence of the heat of the molten steel, will react exothermically producing some metallic element that will alloy with and harden the steel in contact with it. Blind risers also are offset from the desired hard parts of the casting, and in these more of the exothermic material is stored, which reacts and hardens the steel that enters the riser. The fluid hardened steel soaks back into the casting to which the riser is attached and feeds the shrinkage at that point with the hard steel.

Former specifications for manganese bronze included 2 per cent of tin. The resultant bronze was of inferior quality Latterly, the tin content has been greatly reduced and now some metallurgists are beginning to question the use of tin in this particular alloy.

What the Sand Blast Means to the Foundryman

Various Types of These Machines Are Discussed and Their Utility and Value Are Pointed Out for Efficient Operation

By H L Wadsworth

SINCE the discovery of the effect of sand-blasting on an American desert many years ago the art has progressed very slowly until the last few years. Originally applied to foundry work by the English, the Germans took up and developed the process. In fact they carried it so far that automatic machines were built, and are now being built, to a much greater extent in Germany than in this country. I believe, however, that the American idea of building simple machinery of great strength for continuous operation is far ahead of the German system. The Germans go to the extreme to make their machinery absolutely automatic with the result that the machines are complicated and frail and must be operated at a rate so slow that it could not be considered in American foundries.

A German engineer told me on my visit there with a great deal of satisfaction that of course the art of sand-blasting was discovered and developed by the Americans, but that the Germans had brought it up to its present refinement, and he was sure that they would always have first place in its manufacture. With this I cannot agree, as I am sure that there is not an American-made sand blast machine which is not more simple and more efficient than any of those made in Germany.

Sand Blast Outfit No Longer Slighted

Up to within the last few years a sand blast outfit was considered complete when a plain hose machine was installed in a wooden shed, or in an alley alongside the foundry. In recent years, however, the scarcity of labor and the increasing stringency of safety laws has greatly stimulated the development of sand blast machinery, until at the present time, when a new foundry is being planned, the sand blast equipment receives as much attention as the cupolas and cranes.

The sand blast has been, until recently, looked upon as a necessary evil, and consequently the proper selection of its various parts and the installation of them has been given very little attention. This condition is gradually being changed due to the fact that most engineers in planning a new building for a foundry will call in an experienced sand blast engineer, and in most cases follow his suggestions. The foundryman, from bitter experience, is beginning to realize that it pays better to put his money into good equipment to start with than to try to economize with small and incomplete outfits which must be added to in a very short time.

It has been thoroughly demonstrated that in a majority of cases sand-blasting is a most efficient method of cleaning castings, especially where intricate core work is to be cleaned or a surface absolutely free from scale is desired. There are, of course, a few cases, on very simple work, where the ordinary method of tumbling is slightly cheaper, but the finish imparted by the sand blast process is so much superior that it is usually worth the additional cost.

Two Classes of Sand-Blasting

Sand-blasting can be divided into two general classes, hand operating and automatic operating. Hand blasting is by far the most efficient on all but the lightest castings, providing the conditions are proper for the operator. This is due to the fact that scale on a casting is harder in some spots than in others, and requires a longer application of the blast on the harder parts. With hand operation only, the parts that need extensive cleaning will receive it, while the soft scale can be blown off quickly.

With this fact in mind it has been the aim of sand blast manufacturers to constantly improve their designs so that the operator is given the benefit of a strong and well-placed exhaust in connection with proper lighting of the work.

For the general run of large work which cannot be handled on the so-called automatic machines, various special sizes and types of sand blast rooms are designed. The most common is one constructed of heavy steel throughout into which the work is conveyed on cars or trucks operating on industrial tracks or by an overhead monorail or crane. The construction of these rooms varies somewhat. In one design, the floor is made of fine, perforated steel plate through which the sand drops, while the lumps of coarse sand, wire and pieces of iron which fall from the castings, are retained on it. In some systems the sand loads automatically into the sand blast machine from the storage hopper located underneath the floor, between the perforated plate and the pressure tank, while in others it is elevated overhead by means of chain buckets or air suction. In the former system the sand is returned to the nozzle by the air with which it is mixed under pressure through the blast lines, thus completing its cycle without the aid of any mechanical devices, while in the latter the sand is discharged from the elevator into the sand blast machine or gravity nozzle mixer.

For medium-size castings weighing from 50 to 500 pounds, which do not require handling by a crane and which are too large to be handled in tumblers or automatic machines, the rotary table type of sand blast room has become popular in the past year or two, especially in the automobile and light machinery foundries. This type of room consists of a heavy revolving table frame mounted on a central shaft provided with roller bearings at top and bottom. Dividing this frame into two parts is a heavy cast iron partition varying in height from 3 to 6 feet, depending upon the work. On the frame is mounted a series of cast iron grids to carry the work. This rotary table is mounted in connection with a small steel room in which the operator works. For automobile transmission cases, cylinders, etc., a table height of about 18 inches from the floor line has been found most satisfactory as the operator does not have to bend over to do his work. It is only necessary to have a partition height of 3 feet above the table for this class of work.

Convenient Position of Table

For furnace and boiler castings the table is usually made flush with the floor for convenience in trucking the pieces on and off, and the partition height would be increased to 5 or 6 feet, measuring from the floor line. These tables are made in various diameters ranging from 6 to 12 feet.

This type of room really takes the place of two plain sand blast rooms and occupies much less floor space, because while castings are being sand-blasted by hand on the half of the table which is in the room, finished work is being removed and uncleaned work loaded on the other half. When the operator has finished the castings on which he is working, he revolves the table and partition a half turn, which takes the finished work out of the room and puts

Presented at the Boston meeting of the American Foundrymen's association.

the new work before him ready to blast. It has the same effect as two plain rooms side by side, one of which is being unloaded and loaded while work is being blasted in the other.

The rotary table room has several claims on popularity. Less floor space is required for a given tonnage. The operator can work more efficiently because the work is concentrated, the working area is reduced and is strongly lighted from all angles so that there are no shadows produced on the work. These factors result in practically continuous operation with corresponding high efficiency, low initial cost, depreciation, operation and labor.

The success of the regular type of rotary table, sand blast room has been an incentive for further development resulting in the design of a room in which the operator stands outside in the free atmosphere and sees the work blasted through a fine brass mesh wire screen, which prevents the dust and sand from getting out. The sand blast nozzle is operated through a slot of soft rubber in the steel casing of the room. Above this slot are located several powerful lamps to illuminate the work. The operator is not exposed in any way to the action of the blast and does not have to be protected with goggles, helmet or respirator.

Differences in Room Types

The main difference between this and the ordinary type of room is that in the latter the operator is inside of the room where he can turn the castings. This is not believed to be a drawback, however, because he can work so intensively on account of the sanitary conditions that it pays to have another man at the rear of the room loading and unloading the table, or turning the work so it can be blasted on another side. These outfits are especially valuable for boiler sections, furnace parts, gears, machine parts, etc. The actual sand-blasting space of this improved type room is so small that a smaller fan and collector can be used and still maintain a high velocity which keeps the working space practically free from dust and draws out all the fine material to the collectors.

This principle is being rapidly applied to various work in the steel, malleable and brass foundries and various shapes and sizes of plain rooms are being built, which must, of course, be designed specially for their work.

For light work there are several types of automatic machines, the most common and efficient of which is the sand blast tumbling barrel. There are several types of these available, some of which are better adapted to certain work than others. For simple flat work such as stove plate, resistance plates, etc., the automatic rotary table is frequently used. For special work such as radiators, large plates, etc., special machines are designed.

Two kinds of abrasives are used for blasting, of which the most generally used is sand which is marketed under various trade names. For practically all work a hard-grained flint sand manufactured from a quarry rock of comparatively fine mesh gives good results. There is no rule which can be set down governing the selection of sand blast sand. It is a mistake to use any sand because it is cheap, for if it is cheap the chances are that it is easily produced and is of a soft nature which does not transmit the force of the air. A soft sand will also break up quickly and cause unnecessary dust in the room. The purchase of sand blast sand has been given very little thought by the majority of foundrymen, and I believe a careful study of this one point will result in a material saving.

As the most expensive single item in the operation of a sand blast is the compressed air, a few suggestions may be of value. It is a common fault to use a compressor of just sufficient size to operate the machinery which is first installed, with the result that it is run at full capacity all the time and many times at over-capacity. This sooner or later results in a break-down. In addition, if a foundry is not already equipped with an air compressor at the time of installing sand blast equipment there are many uses that the air will be put to which will sooner or later have the compressor running to the limit. As a general rule I might say that to buy a compressor of twice the size called for on the estimate would not be too large in a very short time. I would recommend also the purchase of a standard and well-known make of compressor, so that repairs would be quickly available. Also, if a sale were necessary to make room for larger equipment, its condition would be better and its market value higher. I make this remark because I have seen so many compressors scrapped or sold to make room for larger machines which should have been purchased in the first place. It is usually advisable to use a 2-stage compressor with a short belt drive attachment as being more efficient than the single-stage machine, although its first cost will be higher.

Choice Between Steam and Motor Drive

The choice between a motor-driven and a steam-driven compressor usually depends on local conditions. One reason for the shortage of air in most plants is that compressor catalogs list the piston displacement of the machines instead of the actual air which will be delivered by them. Different makes of the same size have the same displacement, but the efficiency varies all the way from 50 to 80 per cent. It is important, therefore, that the actual delivery of the machine be used in figuring your requirements.

The great strides made in the development of sand blast machinery in the past few years is conclusive proof of its efficiency. I believe that within the next few years more stringent laws will be passed requiring a high standard of working conditions, not only with respect to the ventilation and lighting, but also to the proper protection of parts.

The Effect of Crystallization on Castings

In the production of alloys, crystallization is a phenomenon that merits careful consideration. When some of the constituents of an alloy solidify at a much lower temperature than the balance, an apparently solid casting frequently is produced which contains minute globules of an easily fusible metal. This contracts away from the surrounding solid body and leaves microscopically minute spaces which form routes for liquids under pressure. Even if a small percentage of impurity be added to a chemically pure copper, a casting of the form of an ordinary valve body would not be impervious even at ordinary city water pressure. The water would leak through the intercrystalline space. In the case of iron castings, a minute percentage of sulphur might cause the formation of such spaces, while the actual sulphur itself would be extremely porous. Sharply defined crystal boundaries are not inimical to water-tightness, if the crystals are dovetailed, or interwoven. Such a metal would be tight under almost any conditions, but as a rule, when large and well developed crystals occur, the metal is weak.

Annealing Copper

The annealing of copper in a smoky atmosphere generally is believed to cause extreme brittleness. Commercial copper contains oxide of copper, and the smoky flame removes the oxygen in a short time, entirely changing the molecular condition of the metal. Undoubtedly there is a definite temperature at which copper can be annealed most satisfactorily and after that temperature is attained, it must be held at that point for a certain period. This may be accomplished only by the use of a recording pyrometer.

The chemical analysis of an alloy tells us what it contains and in what proportions, but it does not tell us how they are combined. The microscope gives us this information and consequently, its use should be included in any investigation of alloys and their properties.

Emergency Patterns for a Seven-Foot Gear

Economy and a Saving in Time Were Effected Through the Use of Special Patterns for Molding a Large Mine-Hoist Casting

By J L Gard

EMERGENCY repairs often require a pattern from which only one mold is made. Economy demands that this pattern shall be as simple as is consistent with the character of the casting to be produced. An accident to a 7-foot gear in use in a mine hoist presented such a pattern problem, and the method adopted for its solution met the conditions just enumerated and saved considerable time in furnishing the new casting.

The broken gear had been made in one piece, but it was thought best to mold the new one in halves in order that it might be put in place without dismantling the hoist. For this reason cores were necessary to split the hub and rim, and also to provide the rim-nut pockets, as indicated in the finished casting shown in Fig. 1. Skeleton patterns were made for the gear-tooth and drum-lagging rings, which are concentric, the latter being the smaller. These two rings were fastened together with strips and centered with reference to the hub pattern. Fig. 2 shows the

FIG. 1—FINISHED GEAR CASTING FOR WHICH EMERGENCY PATTERN WAS MADE

complete patterns and core boxes used. The two ring and hub patterns are shown assembled, while at the left are the strikes for sweeping out the hub and ring. The core pattern used to form the space between the arms is shown at *A*; *B* is the shafting-bore core box; *C* is the rim splitting core-box; *D* is the hub-bolt core box; *E* is the rim-nut pocket core box; and *F* is the core box for the hub splitting core.

In making the drag half of the mold, a flat bed was struck off, in which a recess was made of sufficient depth to admit the hub pattern. The main hub-pattern core print was bedded in the bottom of this recess, and the hub pattern itself seated and rammed snug. A sweep was then used to rough out a place for the lagging ring which was centered with the strips that fit into the hub pattern, after which the sand was rammed around the ring. The outer or gear ring was then set in place and centered. Blocks were placed around the periphery of this ring in such a position as to prevent it from shifting after it was replaced in the mold. The gear ring, hub, and drum-lagging ring patterns were then drawn from the sand, after which the gear ring pattern was replaced against the blocks. Sufficient sand was rammed about this pattern to prevent it from

(*Continued on page 367*)

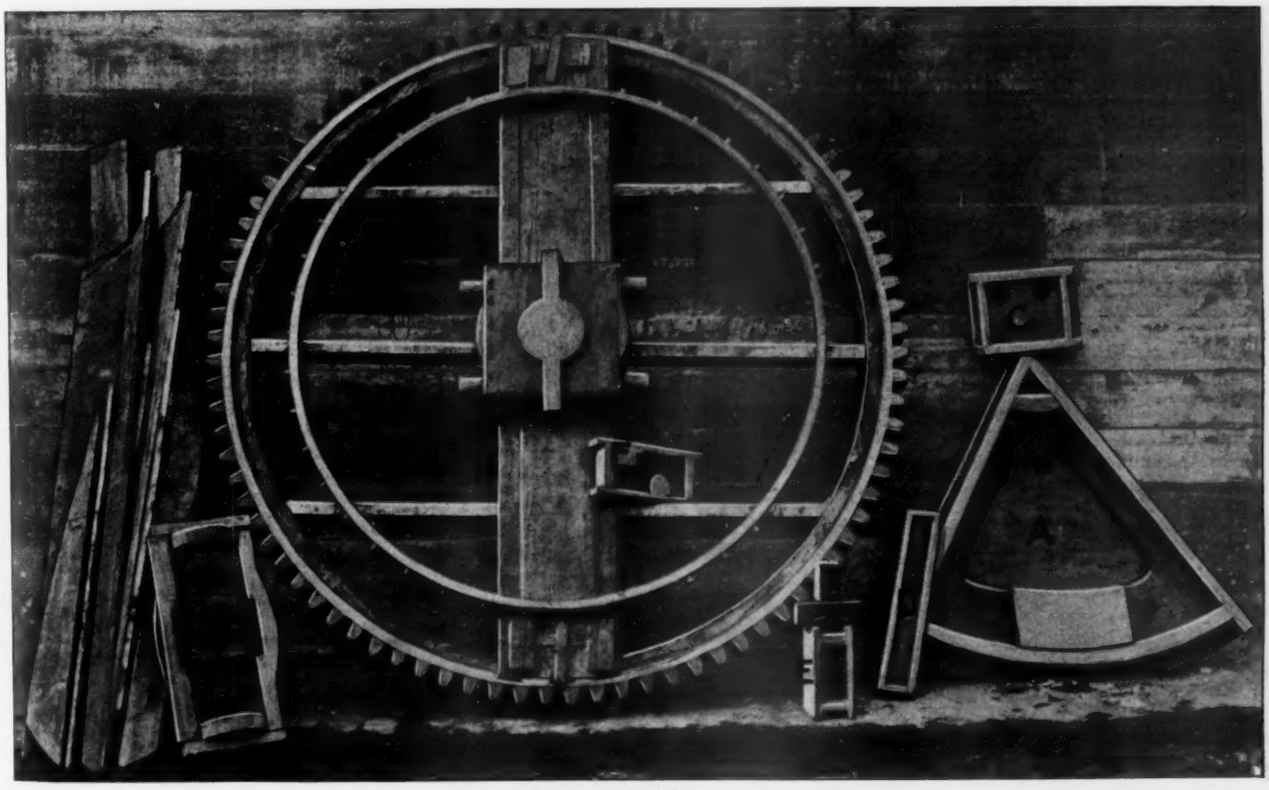


FIG. 2—THE COMPLETE PATTERN AND THE CORE BOXES USED

The Economical Foundry Use of Grinding Wheels

What Wheels to Use and How They Should Be Operated to Obtain the Best Results in Casting Work—A Few Sidelights on Safety Factors

By W T Montague

THE modern grinding wheel plays an extremely important part in the metal-working industries. Its great usefulness begins in the foundry just as soon as the newly-poured castings have become sufficiently cool to be removed to the cleaning floor. Realizing that the grinding wheel is practically indispensable to the foundryman, it is fair to assume that he is vitally interested in those factors that contribute to the economical use of this cutting tool. Although widespread publicity has been resorted to by some of the grinding wheel manufacturers, to demonstrate the methods of using and caring for grinding wheels to obtain maximum service at minimum cost, yet there are evidences that there is much to be learned in this direction.

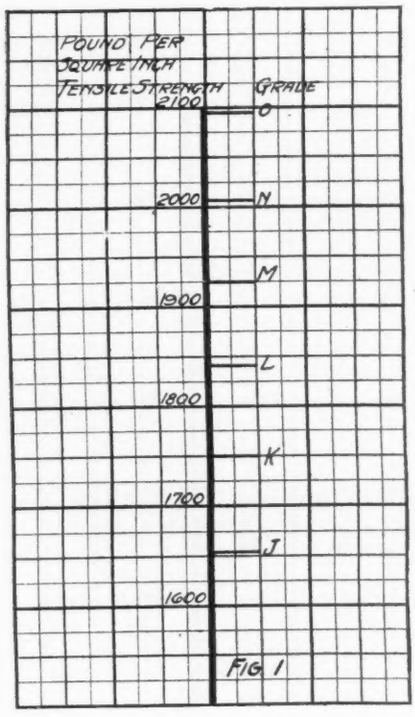


FIG. 1 — BREAKING STRENGTH OF WHEELS OF VARIOUS GRADES

To develop the modern grinding wheel into a tool of usefulness and dependability, has been the abrasive manufacturer's problem, but the problem is not solved when the wheel is produced. The grinding wheel maker must go further than this. He must educate the user so that he can take advantage of all the qualities that science and skill have put into the wheel.

The development of this paper will rest upon the following analysis of factors that will contribute to the economical use of grinding wheels in the foundry, if they are understood and taken into consideration:

1.—A thorough understanding of the grinding wheel as a cutting tool is the first essential.

2.—The castings to be ground must be carefully considered with special reference to their size and shape, the physical properties of the metal, and the amount of grinding to be done.

3.—The condition of the grinding machines must be satisfactory. This refers to weight and rigidity, solid foundations, adequate bearings and proper lubrication.

4.—The speed of the grinding wheel is of the utmost importance and must be held within certain limits if proper cutting action and economy in wheel consumption are to be obtained.

5.—The personal factor must be taken into consideration and allowances made for it.

6.—Adequate records of wheel consumption should be kept and if conditions warrant, industry and economy on the part of the workmen should be properly rewarded.

7.—The use of the grinding wheel should be made safe by proper protection devices.

Theories of Cutting Action

The first portion of this paper will deal with the proven theories of cutting action. They will be gone into quite fully, as it is believed the information will be valuable to foundrymen who may be using grinding wheels.

The composition of the vitrified grinding wheel, which type is almost always used for snagging castings, is as simple as its manufacture is complex. It is made of abrasive grain, clay bond and water. Subsequent burning in a kiln and heat treatment vitrifies the bond and produces that quality termed *hardness*.

The selection of abasive material is almost entirely dependent upon the nature of the metal to be ground. There have been developed for cutting the metals used in castings today, two principal kinds of artificial abrasive—the aluminous group and the carbide of silicon group. Included in the former are alundum, aloxite, boro-carbone, adamite, and the like, and in the latter group crystolon, carborundum, carbolite, etc. Without going into the reasons therefore we will simply state that experience has shown that for materials of high tensile strength, the aluminous abrasives prove the most efficient. This means that the various kinds of steel, wrought iron and annealed malleable iron, automatically call for an abrasive such as alundum. On the other hand, crystolon is chosen for cast iron, including gray and chilled iron, unannealed malleable iron, brass, bronze, aluminum and copper, which are materials of comparatively low tensile strength. This distinction is clear cut and quite easy to remember.

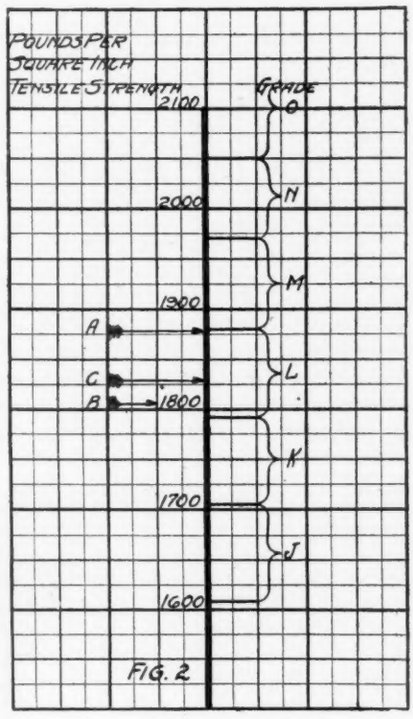


FIG. 2 — BREAKING STRENGTH OF WHEELS OF THE SAME GRADE

The question of what size of grain to use is not difficult to settle. The size of the wheel, amount of material to be removed, and the nature of the metal usually determine this readily. Finish is seldom a consideration and so very coarse grits are used.

How hard to bond a grinding wheel is a point not so readily determined.

Presented at the Boston meeting of the Metals division of the American Institute of Mining Engineers.

The influencing factors are many, including:

1.—Physical properties of the metal to be ground.

2.—Shape and condition of the surface to be presented to the face of the grinding wheel.

3.—Speed of the grinding wheel.

4.—Condition of the grinding machine as to rigidity and steadiness of spindle.

5.—Method of applying the work, that is, whether mechanically or entirely by hand.

In trying to serve our customers and meet their requirements, we are continually reminded that the question of what constitutes a grade or the degree of hardness of a grinding wheel is not fully understood. Grade is the word used to designate relative hardness of any given grinding wheel. By hardness, we do not in this instance refer to the hardness of the abrasive, which is fixed throughout any one wheel. We

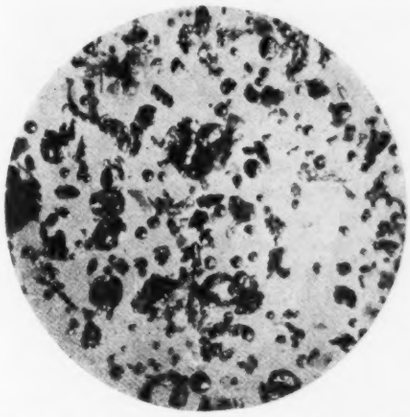


FIG. 3 — CHIPS FROM A GRINDING WHEEL IMPROPERLY OPERATED

refer to the strength of the bond in retaining its grip on the cutting grains of the wheel. If the bond is of insufficient strength to hold the cutting particles in the face of the wheel until they have become dulled and worn from the cutting process, then we call the wheel too soft. On the contrary, an excessively hard wheel is one where the bond retains the grit long after it has become dulled and is therefore practically useless. The word hardness might almost be called a misnomer and perhaps the somewhat more clumsy phrase, *resistance to disintegration*, ought to be substituted.

Grade Defined

This resistance to disintegration, or grade, is actually determined by measuring another separate property of the wheel, namely, the resistance of the bond to the penetration of a hardened steel tool. However, it is known that each of these properties is a function of the other and to measure the force of resistance to disintegration in grinding wheels has been impossible on a commercial scale up to this time.

The belief is quite common that a grade is an exact value. A grade is not an exact value or a definite point in the scale of hardness. It is a range between limits and all wheels which test within this range carry the same grade letter.

One way to measure the strength of the bond is to revolve a grinding wheel at increasing speeds until it bursts. Knowing the bursting speed, the centrifugal force necessary to cause the bond to break down can be readily calculated.

In order to obtain Fig. 1, a lot of wheels were speeded up to a point where the fiber stress, due to centrifugal force, exceeded the strength of the bond and breakage occurred. All of these wheels were of the same size, with the same grit, but of different degrees of hardness. The grade *J* broke when the stress was 1650 pounds per square inch, the grade *K* at 1750 pounds per square inch, and so on. Therefore, one might infer that all grade *J* wheels would burst when this same stress was reached.

Not an Exact Value

Now consider Fig. 2 and let us see what really happens when several wheels of supposedly the same grade are tested. We find that those that have been determined to be of grade *J* hardness will burst at stresses ranging from 1600 to 1700 pounds per square inch, grade *M* at from 1880 to 1790 pounds per square inch and so on. In other words, a grade represents a range of values between definite limits. An understanding of this point is most essential to the users of grinding wheels and will explain many seeming variations in grinding wheel action and life.

Assume a certain snagging operation is being performed, whereby all the factors combine to bring a pressure against the grain on the face of the wheel which causes a stress represented by arrow *C*, Fig. 2. Bear in mind that this is a tangential or peripheral stress, so to speak, not a stress due to centrifugal force. The wheel whose bond has a strength represented by arrow *A* will have a longer life than one represented by arrow *B*. This last wheel will not be bonded strong enough to withstand the grinding forces and will wear away quite rapidly, in fact, much more rapidly than the difference in strength or hardness would seem to warrant. This point has been developed in detail because an understanding of it will eliminate many questions arising between the wheel manufacturer and the wheel consumer. It is needless to say that there is a close limit to the allowable variation and the manufacturer who best keeps within these limits, deserves the greatest confidence of the consumer.

The old idea of grinding considered it as a wearing down of the metal by rubbing or friction. This is now our understanding of the lapping process and modern grinding has progressed far beyond this point. However, if a wheel is bonded too hard for the work at hand, or if the wheel is too fine or composed of an inferior abrasive, the metal is actually rubbed or burned off, as shown in Fig. 3.

Action of Grinding Wheel

The modern grinding wheel of correct specifications for the work produces chips like those shown in Fig. 4. Its action is similar to that of a steel milling cutter. On the face of the wheel are millions of cutting teeth at work every minute, and, although these teeth are not as large nor as strong as the teeth of a steel cutter, and cannot cut as deep, they are capable of working at a much greater speed.

FIG. 4 — CHIPS FROM A GRINDING WHEEL PROPERLY OPERATED

In order for a wheel to cut fast and free, it is necessary for it to wear—that is, for the bond to release those grains that have become dulled and useless. From this it is seen that the grain, which has to the greatest degree the physical property of hardness (we refer to mineralogical hardness), combined with sharpness, is the most efficient and will do the greatest amount of useful work before dulling. It is these very qualities that make alundum superior to emery.

Interesting Experiments Made

A set of experiments recently were carried out, showing how the condition of the face of a grinding wheel affects its cutting action, its ability to remove metal and the power consumed in doing this. The results are shown in Fig. 5, which represents the curve traced by the stylus of a Westinghouse graphic wattmeter connected to a motor-driven grinding machine. Section *A* of the curve shows the no-load power. Then

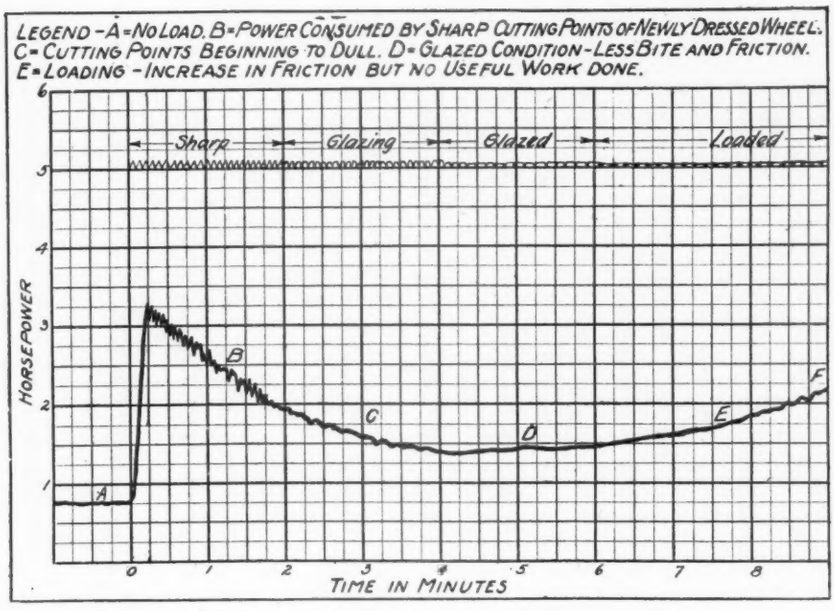

LEGEND - A = NO LOAD. B = POWER CONSUMED BY SHARP CUTTING POINTS OF NEWLY DRESSED WHEEL.
C = CUTTING POINTS BEGINNING TO DULL. D = GLAZED CONDITION - LESS BITE AND FRICTION.
E = LOADING - INCREASE IN FRICTION BUT NO USEFUL WORK DONE.
Sharp
Glazing
Glazed
Loaded
HORSEPOWER
TIME IN MINUTES
A
B
C
D
E
F

FIG. 5—POWER CONSUMPTION UNDER DIFFERENT WHEEL CONDITIONS

a bar of steel was applied to the wheel under a given pressure and this pressure was held constant throughout the tests. What happened? First, the power consumption climbed abruptly as the sharp cutting grain bit deeply into the metal. After two minutes of this rapid cutting, we reached the glazing point and the line *C* resulted. At *D* we were working with a wheel, the cutting points of which were nearly all worn down flat. The power consumption was low because there was practically no useful work being done. The smooth grain simply rubbed and slipped over the bar. At *E*, the steel began to heat up and get sticky, so that particles began to load and smear into the pores of the wheel face. These respective conditions of the grains are illustrated diagramatically from left to right above the curve. The power now climbed again, but still practically no useful work was being done. At *F*, or even before this point was reached, the wheel should have been dressed or resharpened. This aptly illustrates the folly of using a wheel that is too hard or dense to cut freely without resorting to continual dressing.

The action of the ideal wheel is illustrated in Fig. 6. This shows that the glazing period is no sooner entered upon, than the bond suddenly gives way and releases the dulled teeth. New and sharp grains take their place and the cutting is resumed at very nearly the initial rate. A wheel of the correct grain and grade for the operation at hand can oftentimes be dressed by the additional application of pressure on the part of the operator, or by presenting the very sharpest fins on a casting to the wheel face under increased pressure. This means that useful work is being performed while sharpening the wheel, with practically no lost time or wear of dresser cutters. It is this condition that all should aim for in selecting snagging wheels and the workmen should be educated to this kind of grinding.

Some think that in order to make a wheel cut, it must be forced exceedingly hard. This is not true, if the wheel is not excessively hard or fine for the work. A wheel of the correct grain and grade will cut faster if you do not force it too hard. If these points are clearly understood, it will enable you to direct the grinding end of your business intelligently. Failure to grasp the essentials will prove disastrous to economy.

The next factor of importance to economy in the use of the grinding wheel in the foundry is a knowledge of the effect of the physical properties of the metal to be ground. To say that a wheel is desired for malleable iron may not be enough. This expression sometimes covers the annealed malleable and sometimes the white iron, before it has been annealed. If the iron is of the annealed variety, then alundum or an aluminous abrasive should be employed, but if the iron has not been annealed, then by all means use crystolon or some carbide of silicon abrasive. Furthermore, the white iron castings usually require wheels of much greater hardness than the annealed castings and this is readily understood when the difference in hardness, density and structure of these metals is known.

It is a common saying that the harder the metal, the softer should be the grinding wheel. Strictly speaking, this applies only to precision grinding, certainly not to the snagging of castings. Let us consider manganese steel, which, as everyone knows, can be machined economically only with abrasives. This material offers a high resistance to penetration and hence, slightly finer grits are usually employed for snagging castings made of manganese steel than would be used for ordinary carbon steel. Coarser grits would require more manual effort than could be expected from the ordinary workman.

Soft, stringy materials generally call for comparatively coarse grits and medium hard grades. Dense, brittle materials require slightly finer grains and harder grades, sometimes one or both.

The following table may illustrate this to a little better advantage:

Metal	Grade of Wheel
Manganese Steel Castings.	16-Q or R Alundum Vitrified.
Carbon Steel Castings.	10-U Alundum Vitrified.
Brass Castings.	24 Q Crystolon Vitrified.
Chilled Iron Castings.	16, 20 or 24-S, T or U. Crystolon Vitrified.

It is no doubt well understood that

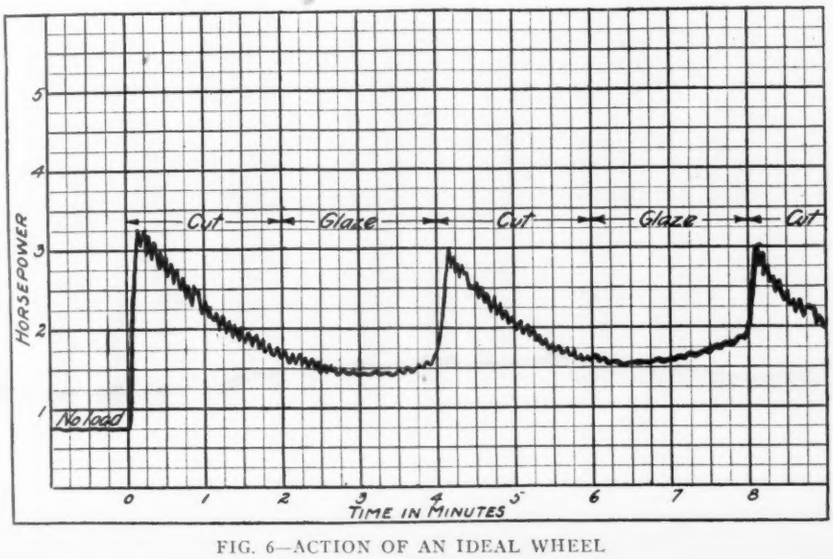


FIG. 6—ACTION OF AN IDEAL WHEEL

the harder the fins and the sharper the contact, the harder must be the grinding wheel. This is necessary to counteract the dressing and tearing action of the projecting metal.

In grinding steel castings, the breaking-off of gates and risers often leaves a very large volume of metal to be ground away. As the arc of contact thus increases there are increased loading tendencies, and sometimes a heavy, black oil is daubed on the metal, to keep the wheel open and thus reduce dressing. After much experimenting, a specially treated or filled wheel has been developed that automatically lubricates the cutting grains and often greatly lengthens the life of the wheel because of reduced dressing. This filling is not thrown out by centrifugal force; it increases the life of the wheel and many times causes faster cutting action because of the lubrication. In instances where the grinding is of a very rough, heavy nature, this special treated wheel shows up to very good advantage and it would not be economical to use anything else.

Condition of Grinding Machine

We now come to the third factor which has an important bearing on grinding wheel economy, namely, the condition of the grinding machine. Economy cannot be expected if the machines are light and shaky, or if the foundations are not solid.

A test conducted by an extensive user of grinding wheels for the purpose of determining whether or not it pays to install concrete foundations under the grinding machines, may interest you. This test was conducted with wheels of the same size and same grain and grade, on the very same machines and identical castings. One set of machines was mounted on concrete or solid foundations and the other on wood or shaky foundation. The results were as follows:

Average life of wheels on wood floor, days	113
Average life of wheels on concrete floor, days	188
Increase in life due to solid foundation, per cent	65
Average saving a month per wheel on concrete floor	$2.00
Average yearly saving per wheel	24.00

Where many wheels are used, this saving is a decidedly large and important consideration. In this case, the concrete foundation paid for itself inside of two months and the saving in wheels will go on indefinitely. As it was, several hundred dollars were saved by this company the first year that concrete foundations were used.

Loose and insecure mooring is also detrimental to the life of the grinding wheel. Don't wait until the machine begins walking around the foundry floor before remedying matters.

Similar figures could be produced to show the saving affected by keeping bearings in good condition. Excessive radial play and end play destroy the wheel rapidly. Many times complaints received to the effect that grinding wheels are not standing up as they formerly did, can be traced directly to bearing troubles. The introduction of harder grades, as for example, from grade *S* to grade *U*, only partially remedies matters because the speed of cutting is sacrificed and the operator has to put forth greater effort to do the same amount of work.

In the case of the medium-sized or large steel foundry, grinding quite a variety of castings, it is important to have the grinding machines properly arranged and grouped so that the work may be ground with a minimum amount of handling.

Extremely large castings that must be ground in place should be gone over with wheels mounted on small portable electric, pneumatic or flexible shaft grinding machines. In the case of the electric machines, all that is needed is a convenient lamp socket or a wall terminal.

Next should come a battery of swing-frame grinding machines to handle the medium heavy castings such as drawbars, locomotive wheels and other similar heavy castings that cannot readily be handled. These machines should be located where prompt crane service is to be had. Then finally, the smaller castings that could be easily handled should be ground on floor stands conveniently arranged.

The proper grouping of machines, segregation of castings, and prompt crane service will make for general efficiency in the cleaning operation. This should be looked out for by a man of good judgment, who could also tell where to grind and where to chip. Much valuable time is lost in trying to chip off fins that could be ground off in a fraction of the time and with much less effort.

A table showing the horsepower required to drive various sizes of bench and floor stands might prove of some help at this point. The values shown in Table I were measured under actual service conditions and, therefore, may be considered reliable guides in the selection of motors.

Much has been said and written about proper operating speeds for grinding wheels, but perhaps some important phases of this subject have not yet been made thoroughly clear. Generally speak-

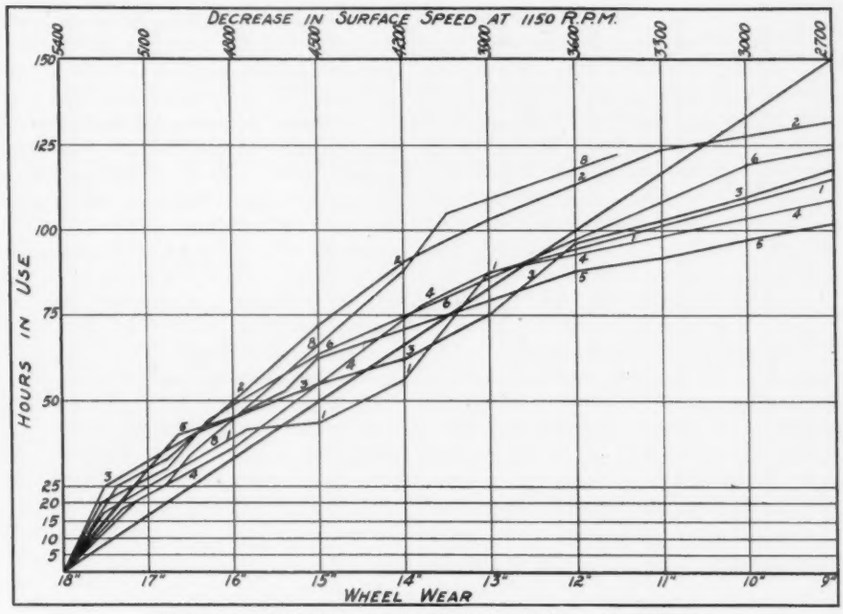


FIG. 7—RELATION OF LIFE OF WHEEL TO SPEED

Table I

HORSEPOWER REQUIRED TO DRIVE VARIOUS SIZES OF BENCH AND FLOOR STANDS

Inches—Machine	Number of hangers	Friction, H. P.	Total H. P.	Net H. P. consumed	Size of motor, H. P.	Wheels used in test
¾ Norton Bench ..... Belt-Driven	12	1.08	1.87	0.81	2	2-10 x ¾ at 5000 S.F.P.M.
1¼ Ransom Bench ..... Direct-Connected	2	0.75	3.00	2.25	3	2-12 x 1¼ at 5000 S.F.P.M.
1½ Norton floor ..... Belt-Driven	5	0.95	3.88	2.93	4	2-16 x 1½ at 5000 S.F.P.M.
2 Norton floor ..... Belt-Driven	11	1.30	4.75	3.45	5	2-24 x 2½ at 5000 S.F.P.M.
10 x 72 Norton ..... Cylindrical	2	2.50 to 3.00	10.00	7.50	10	1-18 x 2 at 5000 S.F.P.M.

ing, the correct speed ranges for the grinding wheels used in snagging castings lie between 5000 and 6000 surface feet per minute. This is fairly well established and quite generally accepted by the manufacturers of grinding wheels. This range was determined partly by long years of experience and partly by physical laws and the desire for an adequate factor of safety. The engineer building bridges, steel structures, machines and what not, recognizes the necessity for an adequate factor of safety and makes due allowance for it. Similarly, the engineer in making grinding wheels sees the great necessity for a factor of safety in operating speed. All snagging wheels made by reliable manufacturers are subjected to a speed test the last minute before being packed that generates a centrifugal stress many times in excess of the stress prevailing under the recommended operating speed.

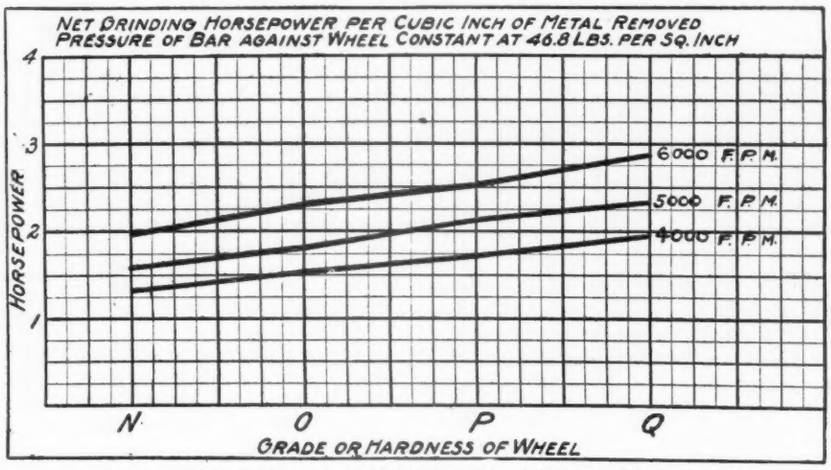


FIG. 8—RELATION OF HARDNESS TO POWER CONSUMPTION

Furthermore, it has been shown there is no appreciable gain from faster speeds, at least not enough gain to offset certain drawbacks. It should be further remembered that the grinding wheel is designed to operate at approximately the recommended speeds and any appreciable deviation calls for adjustments that are not always easy to make or conducive to efficiency.

It is now common knowledge that it is necessary to keep the speed of the grinding wheel approximately within the recommended range, if its productive capabilities are to be maintained. It has been demonstrated that if a wheel's speed is allowed to fall to a very low level, or if it is speeded up beyond a certain point, in both cases reduced cutting ability for the same amount of effort expended is the result. In the case of a sub-normal wheel speed, not only does the productive capacity fall off, but also, there is excessive wheel wear.

To illustrate this point, let us consider the case of an 18-inch wheel, 10 grade *U* alundum, used for snagging steel castings. At 1175 revolutions per minute its peripheral speed is 5500 surface feet per minute, and it cuts and wears satisfactorily. If the revolutions remain the same, at 11 inches diameter, the surface speed is reduced to 3500 feet. What is the result? Every cutting grain on the face of a revolving grinding wheel has a definite amount of energy stored up in it. It is the expenditure of this energy that enables the grain to do useful work and remove metal. Now the energy available varies as the square of the surface speed. Therefore, at 11 inches diameter, the cutting grains have only 40 per cent of the energy that they had at 18 inches diameter and they cannot be expected, therefore, to grind as rapidly. Also, because of the decreased energy stored up in each grain of abrasive, it is less capable of withstanding the resistance offered by the steel and hence is more readily torn from its setting. This, then, explains the difficulty that will be encountered in attempting to grind at very low surface speeds.

On the other hand, if this same 10 grade *U* alundum wheel was giving satisfaction at 5500 surface feet per minute, and an attempt was made to speed it up to 7000 surface feet, no greater production would be realized. This is due to the glazing effect resulting from the increased duty imposed on each abrasive grain.

Keeping a fairly constant surface speed by increasing the revolutions as the wheel wears down, is the proper procedure for maximum cutting ability with minimum wear. This relation of life of wheel to speed is perhaps more clearly indicated in Fig. 7, representing actual results of tests conducted in a large foundry. The curves show the rate of decrease in wheel life as the surface speed drops off. The continuous straight line is for a wheel lasting 150 hours, wearing uniformly from 18 inches to 9 inches in diameter. Surface speed at the start was 5400 surface feet per minute, and, the revolutions per minute being maintained constant at 9 inches diameter, the surface speed was reduced to 2700 feet.

At 5400 surface feet per minute and full diameter, all of the wheels tested start off at a 200 or 250-hour pace. However, before the speed has been reduced 300 surface feet, we notice a change in the slope of the curve indicating reduced life. At 4000 surface feet per minute, 13 inches diameter, the falling off is most pronounced and instead of obtaining 150 hours of wheel life, it ranges all the way from 100 to 135 hours. Had these wheels been speeded up at 15 inches diameter and again at 12 inches, the 150 hours life would have been more nearly attained.

When a user of grinding wheels wishes to avoid the trouble of maintaining fairly constant surface speed, he invariably tries to keep his wheel life up by using wheels of excessively hard grade. The immediate effect of this is increased power consumption and decreased speed of cutting, neither of which are desired. Fig. 8 shows that regardless of speed, successively harder grades require more and more power to remove the same amount of material.

It is quite evident, therefore, from the foregoing that economy in wheel life comes from maintaining fairly constant surface speed as the diameters of the wheels are reduced. This can be brought about by using variable speed motors, or having machines running at graded speeds, to which the worn wheels are shifted at given sizes.

The next point that requires careful consideration is the personal factor entering into the use of snagging wheels. No two men will get the same life or production from a grinding wheel, even though the work and conditions are identical. If the foundry is large and there is a constant duplication of work so that the piece rate can be used, then it is safe to say that harder wheels must be used than where day rate compensation is in force. However, the ideal condition that permits the wheelmaker to specify a free-cutting wheel, is where there is a premium paid for maximum production with minimum wheel wear.

Some men work the corners of the wheel hard, others are abusive in applying the castings, and still others think they must remove ¼ inch of abrasive in dressing, where ⅛ inch would be ample. All of these factors have their effect, and must be allowed for. It is important, therefore, that some kind of a record should be kept, showing just how each grinder uses his wheels. Many times the grinding wheel manufacturer is blamed unjustly for apparent variations in wheel life and hardness. In some of these instances the true causes can be attributed to the operation of this personal factor. For instance, if a

wheel should happen to be on the soft side of grade *S* and it should get into the hands of a grinder who was very hard on grinding wheels, a certain life and production would be obtained. Now, in the same lot of wheels, there might be one that varied slightly the other way or toward the hard side of grade *S*. Suppose that this was used by a man who was more careful in using his wheel. It is evident the wheel would last very much longer under these conditions and hence from a very slight and permissable variation in hardness of wheel, we get a result that would indicate a wide variation, if the personal factor is not considered. This is not idle speculation. It is stated from observation of actual cases.

Where there is a constant duplication of work and the piece-rate is used, there is a very simple, but serviceable method for computing the relative efficiency of various grinding wheels and operators. The operator's earnings on a given class of work per dollar cost of wheel may be considered, under these circumstances, as a very fair means of determining the efficiency of the particular wheel used. To encourage operators to use their wheels economically, a bonus or premium is sometimes paid for all earnings in excess of a given figure. This works out satisfactorily and means that the competent grinder is rewarded for his competency. It also invariably means that free-cutting wheels will be used and hence maximum production is obtained.

Records on Snagging Castings

Here are some actual figures obtained from snagging wheels that are interesting:

Life, hours.	Weight of castings, pounds.	Average per hour, pounds.
127	26,543	208
157½	27,043	172

If no records were kept, the wheel with longer life and slightly greater total tonnage, would undoubtedly have been picked as the more economical to use. However, the wheel with 127 hours life produced 20½ per cent more castings a day and the profit on this increased production more than offset the slightly increased abrasive cost.

Another large consumer of snagging wheels keeps a tabular record on printed cards of the following: Date, pieces ground, weight in pounds, hours of grinding, earnings and wheel loss on diameter. These figures permit the calculation of the abrasive cost per ton of castings ground, and the earnings per ton of castings ground. Manifestly, it is desirable to keep the abrasive cost as low as is consistent with satisfactory earnings per ton. Keeping such records as these makes it easy to pick out the correct grinding wheel, and enables the foundryman to tell just what each of his grinders are doing. He can also tell what the wheel manufacturer is sending him, without guesswork, or resorting to hearsay evidence from a few of the operators. This is decidedly practical and works for economy. It is time large foundrymen paid more attention to this phase of manufacturing cost.

A Specific Case Cited

Here is an example which shows that it is worth while to keep adequate grinding records. A certain large producer of draw-bars was using a hard wheel, 10-*W* alundum. It had fairly long life and turned out a large number of bars before it was used up. On the other hand, the grinders were continually complaining that they had to work too hard and dress too often. Finally the grinding wheelmakers were called into consultation and a test carried out with several different grains and grades of wheel. The result was the choosing of a 10-*U* alundum wheel, one grade softer than the *W*. The complaints ceased as soon as this wheel was put into general use in th foundry, and although the wheels were used up faster, the production was greatly increased and the overhead correspondingly reduced. A brief analysis of this will show up the facts to better advantage:

	Hard wheel, alundum. 10-*W*,	Soft wheel, alundum. 10-*U*,
Grinding cost per ton ground	$0.49	$0.55
Total number pieces ground	1800	800
Pieces ground per hour	8	10.2

The use of the softer wheel increased grinding cost 12 per cent, but increased production 27 per cent and lowered overhead charges because of the increased tonnage turned out in the same time with the same equipment.

Every foundryman who operates a foundry of any size should try and work out a system that will apply to his particular conditions. Let him consult the wheelmaker if necessary and take advantage of whatever experience he has acquired in handling many similar problems. It does not cost very much to investigate, but it is decidedly expensive to continue operating year after year with inefficient and wasteful methods of snagging and cleaning.

Make Your Wheels Safe

A discussion of grinding wheel economy would hardly be complete without some mention, at least, of the necessity of making the use of this tool safe. It is not economy to allow the work to get jammed in between the wheel and the rest, because the wheel undoubtedly would be broken. This is prevented by keeping the rests adjusted close up to the face of the wheel. It is not economy to have one or more grinders going to the hospital every little while to have a foreign body removed from the eye. This can be prevented by supplying an approved type of glass goggle, making the men wear them while grinding. Much trouble also has been caused from flying pieces of chilled iron dresser cutters, which break in the dressing operation. This can be eliminated by using hooded dressers. State laws are beginning to call for closer attention to such features.

Apart from the humanitarian side of this question, it is undoubtedly more economical to employ safeguards where rapidly revolving grinding wheels are used than to trust to chance that there will be no accidents. The cleaning of castings is heavy and wearing work at best, and the least that the foundryman can do is to make the working condition as safe and bearable as possible.

Emergency Patterns for a Seven-Foot Gear

(Concluded from Page 361.)

shifting. The blocks were then removed and the teeth were rammed to the parting line.

The prints of the strips connecting the hub and lagging ring patterns were next filled in to form a flat surface on which to ram the cope, the hub and lagging ring pattern being reversed for this operation. After the cope was finished and all the parts of the pattern removed, the various bolt pocket, shaft bore, splitting and arm cores were set. Prints were not used in locating the arm cores, as it was deemed satisfactory to go without them and thus save the expense of 12 parts.

The method used in molding dispensed with rolling-over the mold. Ordinary flasks were employed. The mold could have been made on the foundry floor without the use of a drag flask, had it been found desirable. The patterns were made by the Gard Pattern Co., Denver, for the Vulcan Iron Works Co. of that city.

Rosin Cores

Various proportions of sharp sand and molding sand can be used in making cores. Molding sand adds strength to the cores before they are baked and produces a smoother casting. Sharp sand confers good venting qualities. The following mixture is satisfactory for many classes of work: Fine white sand, 30 pounds; molding sand, 10 pounds; powdered rosin, 2 pounds. Mix the different ingredients and bake the cores until the rosin smokes. This mixture makes strong cores, and if it proves to be too hard the rosin may be reduced.

Bronze Turntable and Moveable Bridge Discs

Existing Specifications Are Discussed and Changes Are Recommended That Will Prove Beneficial to Users and Brass Foundrymen

By O E Selby

THE uses of bronzes in railroad turntables and movable bridges and the consequent requirements for their qualities differ materially from the uses and requirements of ordinary machinery practice. Turntables and movable bridges, for the purposes of this subject, are to be considered as big machines, but they differ from usual machines in that the motion is slow and intermittent, the pressures are high and in many cases the motion is through only part of a full revolution.

It is only in recent years that bronze bearings have been used extensively for the main bearings of these structures and the development of materials to meet the requirements has followed the appreciation of those requirements. Formerly, turntables (except the Greenleaf type, which had a cast iron center disc bearing) were carried on a center pivot containing a nest of conical steel rollers. This type is still in common use and has many staunch advocates, but the use of a disc bearing center pivot has been increasing to such an extent that the design of such bearings has reached pretty well defined standards.

The fundamental feature of a disc bearing center is that there shall be a bronze disc turning between two hardened steel discs. The lower steel disc is fixed in the stationary pivot; the upper one is fixed in the center of the moving turntable. The bronze disc is confined laterally by the walls of the disc box, but otherwise is free and turning occurs on either its top or bottom surface, whichever happens to offer the lesser resistance. The bronze disc may be lenticular in section and the steel discs concave, or all may have flat surfaces. The flat surfaces are coming into more common use as there is no apparent reason for the more expensive lenticular shape, if the tilting of the superstructure is taken care of otherwise.

The discs range from 14 to 24 inches in diameter. They carry the entire weight of the turntable superstructure and the locomotive, the load being balanced while turning. The resulting pressure on the disc ranges from 1500 to 3000 pounds per square inch in good designs. The desideratum is that the load may be turned with the least force. It does not follow that the turntable with the lowest unit bearing pressure will meet this condition, for the reason that the resulting large disc gives the frictional resistance a larger effective radius. Therefore, the disc must carry the load at a high bearing pressure and with a low coefficient of friction. This requires a hard bronze, much harder than for ordinary machinery bearings. Moreover, the quality of the bronze and the condition of the lubrication must be such that there will be no bad effect from intermittent use at irregular periods.

What has been said about turntables applies without change to center bearing swing bridges except that the bridge carries only the weight of the moving span and the discs are larger; some as high as 42 inches in diameter have been furnished.

It goes without saying the bronze discs as heavy and expensive as these must not be subject to much uncertainty as to their quality. This requires the most carefully considered specifications and the highest skill in the bronze foundry.

Bronze-Lined Trunnion Bearings

The other type of movable bridges, those moving in a vertical plane such as bascule and lift bridges, require bronze-lined trunnion bearings of great size. These trunnion bearings are subject to the same conflicting conditions as between low unit bearing pressures and large radius of frictional resistance. The motion is slow and, on account of only partial rotation, the lubrication is difficult.

Discs and large trunnion bearings may then be said to constitute the *special* uses of bearing metals in turntables and movable bridges. The bridge machinery and the turntable truck wheels call for bearing metals like those in other heavy machinery, except that the difficulty of renewals and the consequences of a shutdown make the integrity of the bearings of the highest importance.

Naturally, in the early periods of the development of the special uses of bronze in these structures, recourse was had to the knowledge of the bronze founders, which, of course, was limited to their experience in producing bronze for the common uses. Some exasperating failures led the designing engineers to look into the subject, and to attempt to break through the wall of secrecy with which the founders surrounded their art. It is not surprising that the attempt to enforce specifications in an art requiring so much of skill and special knowledge was resented, but finally there have been developed a few bronze foundries in which the most highly scientific methods are used with correspondingly reliable and uniform results.

The necessity for uniform specifications for bronzes for the special uses here considered led the committee on iron and steel structures of the American Railway Engineering association in 1914 to take up the study of the subject. The report and specifications which were developed by a subcommittee of which the writer was chairman are printed in the proceedings of the seventeenth annual convention of the association. On account of the writer's association with the report, it will not be out of place to extract freely from it.

The physical properties desired in bronze depend on the use to be made of it. For machinery bearings with low pressure and high speeds, under constant operation, the strength of the bronze is less important than its antifriction and wearing qualities. For bearings of movable bridge trunnions and discs, turntable discs and similar slow moving parts operated infrequently and carrying heavy pressures, the bronze must be hard enough and strong enough in compression to reduce friction to a minimum and not to flow or distort under the pressure. For worms, gears, nuts, etc., the bronze must have tenacity and hardness as well as antifriction and wear-resisting qualities. The differentiation of bronzes according to the uses mentioned is a matter of recent years; the earlier practice was to use one kind for all purposes.

The hardness and strength of bronze increase with the amount of tin. The introduction of lead increases the wearing qualities and softens the metal besides cheapening the product. Zinc increases the tensile strength but is injurious to the alloy for bearing purposes. It should not be used except in bronze for the third purpose mentioned, and then only in small quantities, as too much causes a segregation of the tin and the formation of hard tin spots.

It appears that the introduction of

Presented at the Boston meeting of the American Institute of Metals.

lead decreases the wear but increases the friction. A table of experiments by Clamer printed in "Lubrication and Lubricants" by Archbutt and Deeley shows that, while the wear decreases proportionately with the increase in lead, the friction in the cases of lead exceeding 5 per cent was as high as 40 per cent greater than in cases having no lead. These results are said to have been confirmed by Spare in the Cornell laboratory. There are no definite experiments known which show lead to improve the antifrictional qualities.

The necessity for a harder bearing metal for heavy pressures has developed a series of formulas containing upward of 20 per cent tin and no lead. The metal produced has an elastic limit in compression of from 24,000 to 40,000 pounds. The permanent set under 100,000 pounds on a one square inch cylinder 1 inch high is from 1/16 to 1/10 inch.

Table I

CHEMICAL AND PHYSICAL PROPERTIES OF BRONZES GIVEN IN EXISTING SPECIFICATIONS

	—GRADE—			
	A	B	C	D
Copper, per cent	80 about	85 about	80 about	88 about
Tin, per cent	20 about	15 about	10 about	10 about
Lead, per cent	.....	.....	10 about	.....
Zinc, per cent	.....	.....	.....	2 about
Phosphorus, per cent	1.0 max.	1.0 max.	1.0 max. 0.7 min.	0.25 max.
Other elements, per cent	0.5 max.	0.5 max.	0.5 max.	0.5 max.
Elastic limit in compression, pounds per square inch	25,000 min. 40,000 max.	19,000 min. 23,000 max.	15,000 min. 20,000 max.	14,000 min.
Permanent set under 100,000 pounds	0.06 min. 0.10 max.	0.12 min. 0.25 max.	.....	.....
Yield point in tension, pounds per square inch	.....	.....	.....	To be recorded
Ultimate strength in tension, pounds per square inch	.....	.....	.....	33,000 min.
Elongation in 2 inches, per cent	.....	.....	.....	14 min.

A considerable number of engineers believe in specifying the physical properties only and leave the chemical composition to the maker. Others modify this course by stipulating certain control over the formula, but make the physical requirements the criterion for acceptance.

The third class of bronze, that requiring high tensile strength, is best secured by the introduction of from 1 to 2 per cent of zinc. This constitutes gunmetal. For this purpose the ultimate tensile strength and percentage of elongation seem to be more proper physical requirements than the compression characteristics.

Specifications and Their Discussion

The specifications for bronze bearing metals for turntables and movable railroad bridges provide that phosphor bronze shall be a homogeneous alloy of crystalline structure. It shall be made from new metals, except that scrap of known composition produced by the foundry at which the bronze is cast may be used. It shall not contain sulphur. The phosphorus shall be introduced in the form of phosphor-tin or phosphor-copper. Castings shall be sound, clean, and free from blowholes, porous places, cracks and other defects.

The alloy shall be cast into ingots and allowed to cool and the castings shall be poured from the remelted ingots. Care shall be exercised that the metal is not overheated and that the temperature at pouring and the conditions of cooling are such as will be most likely to secure dense castings.

There shall be four grades, as follows:

Grade A is to be used for contact with hardened steel discs under pressures exceeding 1500 pounds per square inch such as are used in turntables and and center bearing swing bridges.

Grade B is to be used for contact with soft steel at low speeds under pressures not exceeding 1500 pounds per square inch such as trunnions and journals of bascule and lift bridges.

Grade C is to be used for ordinary machinery bearings.

Grade D is to be used for gears, worm wheels, nuts and similar parts which are subjected to other than compressive stresses.

The chemical and physical qualities shall conform with the requirements given in Table I.

The chemical analysis of each heat shall be furnished.

Test specimens shall be made from coupons which are a part of the casting and which have been fed and cooled under the same conditions as the casting.

Compression test specimens shall be cylinders 1 inch high and of 1 square inch area. The elastic limit in compression shall be the load which gives a permanent set of 0.001 inch.

Tension test specimens shall be turned from a coupon not less than 1 inch in diameter to the form shown in Fig. 2 of the American Railway Engineering Association General Specifications for Steel Railway Bridges. The diameter of the turned specimen shall be ½ inch.

At least one compression test shall be made from each melt for Grades A, B and C; and one compression and one tension test for Grade D. For castings weighing over 100 pounds, finished, the prescribed tests shall be made for each casting.

The hardness of the finished castings shall be tested by the Brinell ball method and a record of the test furnished. The ball shall be of hardened steel, 10 millimeters in diameter. The load shall be 500 kilograms and shall be applied for 30 seconds to a finished plane surface. At least two hardness tests shall be made upon each heat. A test shall be made on each trunnion bearing and each disc.

Discussion of Specifications

The specifications which accompanied the report are given in the foregoing. They were submitted tentatively in the hope that their use would develop whether they were suitable and practicable or not. It is to be regretted that little of such use has been made. One of the bronze makers in the Pittsburgh district, who does a good deal of bridge bronze work, said early this year that he was not aware that such specifications had been formulated.

The writer has, by conferences and correspondence with interested experts, found out some of the points in the specifications on which differences of opinion exist. They all relate to Clause 4, and are:

a.—The use of both chemical and physical requirements.

b.—The use of the elastic limit in compression.

c.—The extent to which the Brinell hardness number may be used as a criterion of quality.

d.—The proper limits of permanent set.

It will be necessary to discuss all four of these points together. The inconsistency of specifying both chemical composition and limitations of physical qualities is well known and admitted. It is to be noted that the specifications do not attempt to give more than the approximate chemical composition. The use of the word *about* after the contents of copper, tin, lead and zinc has caused some misunderstanding. The makers seem to feel bound by the figures and the degree of latitude to be allowed is not indicated. The representative of a prominent bridge company told the writer that his company had tried to manufacture bronze to grade B and had failed to keep within the physical requirements, and that later they had tried to get the bronze made by bronze companies who refused to quote on these specifications. Plainly, the use of the word *about* has been misleading, and what was intended largely for information as to the chemical makeup which might be expected to produce the phy-

sical qualities desired, has been interpreted to be control of the chemical composition.

There are good reasons that there should be some degree of chemical control, however. This does not refer to the limitation of the deleterious ingredients, the desirability of which nobody questions, but to the control of the makeup ingredients, copper, tin, lead and zinc. The principal reasons are that an excess of one of the beneficial ingredients, such as tin, may produce a deleterious effect, and that the control of the physical qualities is not reliable enough to be used independent of knowledge of the chemical composition.

An increase of tin content increases the hardness, which may be desired, and also the brittleness, which never is desirable. There must then, for each grade, be a point of sufficient hardness and unobjectionable brittleness where the tin content must stop. The limits are narrow; that is one reason bronze founding is an art requiring great skill. If we could measure the hardness and the brittleness exactly, we might fix their limits and let it go at that, but unfortunately, we have no such exact control of those qualities and we must have the further protection of a limit to the tin content.

Objectionable Ingredients

Similar remarks apply to the ingredients other than tin. Lead in any quantity is objectionable in grades A and B, and zinc is not beneficial in grade C. The case is analogous to that of an important railroad crossing which must be guarded by both gates and flagmen.

George H. Tinker, in his paper published as a part of the committee report mentioned, says: "It is recognized that neither compression nor hardness tests on bronze always give concordant results, owing to the effect of various conditions of manufacture. That is one very good reason for controlling the chemical composition within narrow limits."

Curves showing plotted experiments by Thurston, Proceedings Institute Mechanical Engineers, 1895, show that beyond about 18 per cent tin content the tensile strength falls rapidly and the elongation is practically zero. Should the founder then be allowed to increase the tin content without limit to meet some perhaps ill-considered hardness requirement?

The purpose of physical tests of any material is the determination, directly or indirectly, of the qualities desired for the purpose for which the material is to be used. If the use to be made requires principally tensile strength, naturally tensile strength is the quality tested. In the case of other uses, the direct testing of the qualities desired is not so simple.

Quoting again from Mr. Tinker's paper: "A bearing metal should have a low coefficient of friction, high resistance to wear and sufficient strength to resist distortion by crushing. In the case of gears and screws, a certain tensile strength and resilience are also required.

"The final criterion for the suitability of a metal for a specific purpose is its behavior under actual use. To determine the probable behavior of a metal submitted for such purpose, the nearer the test applied duplicates the actual conditions of service the greater our confidence in the probable outcome. It is also necessary that the test should be easily, quickly and cheaply applied, and last but most important, it should give concordant results.

"Friction tests are difficult to make; so also are wear tests. Resilience tests are unsatisfactory. There remain compression and tension tests which fulfill all the requirements of a test of a bearing metal except that it appears doubtful if they furnish sufficient evidence of the probable behavior of the metal in service."

The determination of the elastic limit in compression is one means of arriving at the desired qualities of strength, hardness and resilience. If the test could be easily, quickly and cheaply applied and would give concordant results, it would be entirely satisfactory. But there is evidence that it cannot be cheaply applied and at the same time give concordant results. When 0.001 inch permanent set is taken as the elastic limit, it is necessary to work to ten-thousandths. This requires accurate and expensive machine work. One bronze maker said that recently they tried to get an accuracy of finish such that no two readings on the top and bottom faces before test would vary more than 0.0005 inch. It took an expert machinist six hours to scrape a test piece to this limit. This, of course, is almost prohibitive and any smaller degree of accuracy casts doubt on the results.

These conditions make it desirable to find a substitute for the elastic limit in compression as a test for acceptance or rejection. B. R. Leffler thought that he had found such a substitute in the Brinell hardness, and in 1915 brought out a specification requiring only the Brinell hardness number and no other physical test except for the grade requiring tensile strength. Mr. Leffler's specifications, revised in February, 1917, have restored the elastic limit in compression (with wider limits than formerly) and the permanent set under 100,000 pounds load. Evidently, the hardness alone is not a satisfactory criterion of all the qualities desired.

V. Skillman says: "Regarding the Brinell test, I would consider this simply a different form of compression test. It is, I believe, a good check on the figure for permanent set, but I do not believe it gives any new data. If the permanent set is found, the Brinell hardness can be estimated closely enough for all practical purposes."

Mr. Tinker, in the paper referred to, says in regard to hardness: "The latest theories of friction lead to the corollary that the harder a substance is, the greater will be its antifriction qualities. There is some evidence of a definite relation between hardness and tensile strength. The existence of a definite relation between hardness and compressive strength is not established. As to the relation between hardness and resilience, there is a point in the hardness scale where hardness is accompanied by brittleness and resilience decreases. It thus appears that hardness may or may not indicate the presence of the qualities desired in a bearing metal.....It should be kept in mind that the hardness test is an indirect test. A metal is suitable for a bearing not because it is hard, but because being

Table II

SUGGESTED MODIFICATIONS IN CHEMICAL AND PHYSICAL REQUIREMENTS

	—GRADE—			
	A	B	C	D
Alloy of	Copper and tin	Copper and tin	Copper, tin and lead	Copper, tin and zinc
Tin, per cent	20 max.	17 max.	11 max.	11 max.
Lead, per cent	.....	.....	11 max.	.....
Zinc, per cent	.....	.....	.....	2.25 max.
Phosphorus, per cent	1.0 max.	1.0 max.	1.0 max.	0.25 max.
Other elements, per cent	0.5 max.	0.5 max.	0.7 min. 0.5 max.	0.5 max.
Elastic limit in compression, pounds per square inch	24,000 min.	18,000 min.	.....	.....
Permanent set under 100,000 pounds.	0.06 min. 0.10 max.	0.10 min. 0.20 max.	.....	.....
Permanent set under 30,000 pounds	.....	To be recorded	To be recorded	.....
Yield point in tension, pounds per square inch	.....	.....	.....	To be recorded
Ultimate strength in tension, pounds per square inch	.....	.....	.....	33,000 min.
Elongation in 2 inches, per cent	.....	.....	.....	14 min.

hard it is likely to have a low frictional resistance, or is likely to wear well, or is likely to be able to sustain a certain pressure without distortion.... The compression test is a direct test of one of the qualities desired and should not be discarded."

Mr. Skillman says: "If a substitute were desired for the elastic limit in order that an indication would be obtained of the behavior of the bronze at more nearly working pressures than the destructive pressure of 100,000 pounds which is required, I would suggest that a test at say 25,000 or 30,000 pounds be also required which should fall between certain limits. Such limits would have to be decided upon after investigating a number of compression curves which covered the load selected."

There is an objection to the use of too wide limits for the compression test, both for permanent set and elastic limit in that it would make it possible for founders who are not equipped for and are not accustomed to particular work, to meet the specifications with material which would not be of the desired quality.

Other Limits Suggested

Clement E. Chase suggests the elastic limit as the bottom limit with the tin content as the top limit. This is not in the nature of a compromise as might appear, but rather to applying the limitations where they will do the most good and removing them where the good qualities of the material would not be jeopardized. Mr. Chase argues that it is the brittleness and not the high elastic limit which is objectionable; it is the tin content which influences the brittleness, therefore, that is the thing which should be limited and if a manufacturer is able by skill to secure a higher elastic limit with a given tin content than another, he should not be penalized.

There is little controversy about the test for permanent set in compression. It is direct and easily and cheaply made and gives concordant results. The only question is as to the limits. Apparently both limits for grade B are too high. Mr. Skillman suggests 0.10 to 0.20 inch.

In view of the features discussed, the writer suggests the substitution of the following clause for Clause 4 of the specifications published in the proceedings of the American Railway Engineering association and advocates the use of those specifications so modified:

4.—The chemical and physical qualities shall conform with the requirements in Table II.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Holes in Brass Castings

We are experiencing considerable difficulty on account of holes in brass castings. They are not caused by wet sand or by not skimming the brass before pouring. We are using a good grade of brass, block tin and phosphorus. Can you tell us what causes the difficulty?

If the sand is not at fault and no dross or charcoal is allowed to get into the castings, and if the metal is known to be good before it is melted, then the difficulty must be due to careless melting methods. If all the mixture cannot be put into the crucible cold, use a deepener on top of the pot to increase its capacity, and put the brass and the copper in together. Place several small hardwood blocks on top, and a little salt and melt quickly. The metal ought to be perfectly fluid under a cover of charcoal produced by the hardwood blocks, then add the phosphorus, stir thoroughly and follow with the mixture. Pour on the warm side. If these instructions are carefully followed no further trouble from porosity should be experienced.

Trolley Wheel Mixture

We have been experimenting with the use of iron chills for coring out trolley ears, and have coated the chills with various mixtures consisting of different waxes, gasoline and plumbago combined, etc., but the castings come full of blow holes, and we would like to know if there is any successful way of making these castings by the use of chills instead of cores. Would the iron chills have any tendency to harden the castings and cause brittleness? We have been using the following mixture: Copper, 92 per cent; tin, 6 per cent; zinc, 2 per cent, and 0.25 per cent of 15 per cent phosphor-copper.

If the iron chills are merely used to core out the groove of the ear, coat them with linseed oil and then dust on some very fine, sharp sand from a pepper shaker. Coat the chills uniformly with the sand but do not let it pile up on the chill. Put on one even layer only, then dry the chills in the oven until they resemble an oil core, when the sand will be found firmly cemented onto the chill. Use them warm. Do not core the molds until ready to pour and proceed to fill as quickly as possible after the molds are closed onto the chills. If properly done the chills will not blow. For splicers it will be necessary to use sand cores bonded with oil, as chills would crack the castings. The iron chills will not cause brittleness. The mixture used for trolley wheels is known as the standard trolley wheel mixture and should give good results. The arcing is supposed to be due to the zinc, therefore, it might be well to omit this metal and use the following alloy: Copper, 93 per cent; tin, 6 per cent, and 15 per cent phosphor-copper, 1 pound.

Background for Bronze Name Plates

We would appreciate your informing us as to the best method of obtaining a durable black background for cast bronze name plates. We are using the following mixture: Copper, 84 per cent; zinc, 12 per cent; tin, 2 per cent; and lead, 1 per cent.

One of the best methods of producing colored backgrounds for name plates is to coat them with sealing wax of the desired color. The use of a black sealing wax will produce a black background, and a red wax gives a red background. It is done after the lettering has been polished. The plates are laid back down on a hot plate and the wax is melted on and spread evenly, care being taken to prevent its boiling, When the wax is evenly spread the plates are removed, to facilitate which it is advisable to place them on pieces of flat sheet iron, which are lifted away with the plates when the latter have been properly coated. When the plates are cool the high lights are cleaned off with a cloth dipped in wood alcohol, after which the surface of the plate is polished with a cloth dampened with turpentine.

Pitting of Yellow Brass Castings

We are making yellow brass castings which are badly pitted on the surface. We exercise great care in ramming the molds and we use the sand at the proper temper. The metal is covered

with charcoal and glass and when pouring, the heads are kept full. Our sand contains a high percentage of loam, and we are inclined to attribute our trouble to this.

If the sand contains considerable loam, it would be advisable to mix from 10 to 20 per cent of sharp sand with this and to use this prepared sand for a facing over the pattern, spreading it sufficiently thick to permit of having plenty of vents to convey the gases from the mold. Probably more draft also will be required to melt the low grade of coke that is now available, and if compressed air or steam can be obtained, a simple way of urging the fires would be to introduce a jet of air or steam into the stack while melting metal for large castings. The flues also should be examined to prevent choking and the grate bars should be given similar attention. The presence of surface pits on castings usually can be attributed to the sand or the ramming of the mold and, as a rule, the admixture of sharp sand will cure this trouble. On the other hand, if the castings are spongy on the surface, it is probable that the sulphur in the coke may have something to do with it, although it is difficult for sulphur to attack the metal if it is well covered with glass. The addition of 0.25 per cent of 30 per cent manganese copper also might be made to advantage.

Using Risers Judiciously

We are making large bushings, bearings and valves, weighing from 100 *to* 1000 *pounds each. The alloy is a special government bronze consisting of copper,* 57 *per cent; zinc,* 41 *per cent; tin,* 1 *per cent; iron,* 0.75 *per cent, and aluminum,* 0.25 *per cent. In some castings, however, the aluminum may run higher We experienced must difficulty in preventing the castings from shrinking, although we use chills wherever risers cannot be employed. The shrinkage shows in the form of cracks and segregations similar to aluminum. We are of the opinion that this can be eliminated by the proper use of risers and we would like to have your advice on this question.*

The idea that the shrinkage can be overcome by the proper use and disposition of risers is eminently correct, in fact, that is what should be done. A chill will never feed a casting and in using chills, if proper provision is not made to supply metal to the part of the casting ultimately drawn upon to supply the shrinkage, in spite of all the chills that can be used, the casting will be unsound. The value of chills is to cause a casting to become solid in a uniform manner, that is, to prevent one part from remaining liquid long after the other parts have set, as the part last liquid will have been robbed of metal by all the other parts that set first. This results in holes and depressions in the heavy parts. The remedy is to study the casting until it is apparent about how the metal will act in solidifying and then to place chills where they will tend to prevent the heavier sections from setting last. In the corners of angles are good places. Next, set risers large enough to remain liquid after the parts they are to feed are solid, wherever it is thought they will be needed. On heavy and complicated castings it is chaper to remelt a few extra heavy risers than to have to make the casting over several times. Do not be afraid to use risers and bear in mind that a riser less than 2 inches in diameter is of little value for any metal cast in brass foundries.

Scrap Sheet Copper Causes Porosity

It has been our experience that when scrap sheet copper is used in place of ingot copper for making brass and bronze castings, the latter are porous.

In melting sheet copper a much greater surface is exposed to oxidation than when melting ingots and, therefore, more oxygen is absorbed, resulting in a tendency toward porosity of alloys made by the use of these thin copper sheets. The difficulty will be obviated if care is exercised to prevent oxidation and this may be effected by charging charcoal and salt with the scrap. As soon as the copper attains a dull red heat it should be crushed down into the bottom of the crucible with an iron bar. Allow this metal to melt under a cover of charcoal, then fill the crucible with additional scrap and as soon as this is heated to redness, force it down into the bath of liquid copper. Repeat this operation until the crucible is filled. When the copper is melted, add a small amount of phosphor copper, not to exceed 0.25 per cent and follow with the white metals and stir thoroughly. We believe that by following this course of procedure porosity will be eliminated.

Core Mixtures for Brass and Iron Castings

We would like to obtain mixtures for cores suitable for brass, aluminum and iron castings of thin section as well as several facing mixtures.

One mixture, varied to meet the requirements of the metals for which the cores are to be used, probably will serve your purpose. Dextrin can be employed to advantage for aluminum cores and a typical mixture would consist of old floor sand, 33 per cent; new molding sand, 33 per cent; sharp sand, 33 per cent, and dextrin, 1 per cent. This mixture may be varied to meet the need for cores for the different metals. Thus, if the cores are too hard, the dextrin may be reduced and if too soft, the dextrin content may be increased. If the cores are too close, the molding sand is reduced and the sharp sand increased, etc. It is unnecessary to face molds for small castings. If the castings are very small any good grade of brass sand will serve the purpose.

A High Tensile Bronze Mixture

Will you kindly give us a mixture for a bronze that will have a tensile strength of 45,000 *pounds per square inch?*

The term *bronze* is so loosely applied that we are undecided whether an alloy of copper with tin is desired, or whether any alloy of 45,000 tensile will meet the requirements. The true bronzes are the copper-tin alloys, and it is a very difficult problem to get 45,000 tensile with these alloys, although for some government work this is specified. An alloy of copper, 90 per cent and tin, 10 per cent, will meet the requirements if skillfully made and molded otherwise it will fail miserably. It, therefore, becomes a question of melting and molding. The casting should be fed properly to prevent voids between the crystals of the metal, which are the most prolific source of weakness. If a copper-zinc alloy can be used, this tensile strength requirement is easily met. The following alloy will be satisfactory: Copper, 59.40 per cent; zinc, 40 per cent; tin, 0.50 per cent, and aluminum, 0.10 per cent. First run the alloy into ingots and on the remelt add an additional 1½ pounds of zinc to compensate for volatilization.

Gating Patterns for Brass Castings

We would like to obtain some suggestions regarding the best methods of gating large and small patterns for electric motors, and motor generators.

In order to give advice regarding the best method of gating any kind of molding work, it is essential that the configuration of the pattern be known. The best way is to see the pattern itself, but sometimes the best method of gating can be outlined from a view of the photograph. The best way of solving this problem would be to engage the services of a good molder for a time, and to observe how he makes the castings.

Generally speaking, brass castings come smoother when run from the bottom so that the metal rises in the mold. Thin castings require a number of gates, and when large in

area, may require to be poured with several pots. Large castings should be gated at the lowest point and risers must be attached to the highest points in the cope to feed the metal as it shrinks. The sand should be fine for small work and rather coarse for heavy work.

Mixture for Blast Furnaces Tuyeres

We would like a mixture for blast furnace tuyeres. The alloy which we have been using has produced spongy castings. These tuyeres must withstand a hydraulic pressure of 600 pounds.

Blast furnace tuyeres usually are made of copper deoxidized with silicon. The copper should be melted hot under a cover of charcoal reduced to small size and five minutes before removing it from the furnace, 10 per cent of silicon-copper should be added in the proportion of 1.5 per cent. The copper then is vigorously agitated with a graphite stirrer. Never use an iron stirring bar in copper deoxidized with silicon, as silicon and copper form a combination that causes trouble in the production of copper castings. After the castings are cleaned, it is customary in some shops to peen the surface which closes the grain of the surface metal and enables the tuyeres to better withstand the hydraulic pressure. All hollow copper castings subjected to high pressure should be peened as this hardens the metal and causes it to become more dense. Cast copper always is soft and more or less open in texture and the peening greatly improves it. The value of peening is recognized by coppersmiths and if you are regularly engaged in the manufacture of tuyeres, it might be advisable to employ a coppersmith regularly to do this work.

Overcoming the Cracking of Galvanizing Tanks

We have experienced difficulty in our galvanizing department due to the cracking of the cast iron tanks in which the zinc is melted. These tanks are 45 inches wide, 60 inches long, and 12 inches deep, with walls 1 inch thick and bottoms, 1¼ inches thick; the corners are curved. They crack along the bottoms and ends. Is there a special kind of material we could use, or would it be possible to line the pot to prevent the zinc from attacking the iron? Also, kindly let us know a good flux to use, as after a time the zinc becomes very hard to melt, evidently from some impurities absorbed.

We believe that you would have better success with rolled wrought iron or dead soft steel tanks, as the life of a wrought iron kettle is about one year when uniformily heated. The temperature of the zinc bath is the important factor in the destruction of pots by corrosion, which causes the failure of wrought iron pots. The solubility of iron in zinc has been found to be about 9 times as great at 500 degrees Cent., as at 400 degrees, and 30 times as great at 530 degrees; therefore, if a wrought iron pot is used, the temperature of the zinc should be kept as low as possible, and the pot will prove cheaper than the cast iron pot. It is possible that by increasing the curvature of the tank that the cracking could be avoided, if it is desirable to adhere to cast iron. The best flux to use on zinc is sal-ammoniac. The zinc becomes hard to melt because it absorbs iron from the tank and becomes an alloy of iron and zinc. It may contain 4 per cent and upward of iron. The dross settles to the bottom of the tank, and should be removed at the week end with a long handled, perforated ladle. If this dross is left in the bath the melting point of the zinc is raised and this probably causes the tank to crack. The zinc containing iron should be sold to refiners. If the zinc requires thinning after the removal of the dross, this should be done by the addition of one or two small pieces of sheet aluminum.

Tests on Brass Sweepings Show Good Results

SUTTON, Steele & Steele, consulting engineers, Fort Worth, Tex., recently conducted a numer of test on brass sweepings furnished by the Midland Brass Works of that city. The results show that it is worth while to pay attention to reclaiming the material in question as the following summary shows.

The tests were made of four bags of material, as follows: One 120-pound sack of sand from tumbling barrels, one 148-pound sack of machine shop sweepings, and two 322-pound sacks of grinding wheel dust.

In testing the sand from the tumbling barrels the material was first passed through a 12-mesh screen to remove foreign particles, such as pieces of castings, shavings, etc. The material that remained on the screen weighted 2½ pounds and represented 2.36 per cent of the original sample, while the material that passed through the screen weighed 103.5 pounds, representing 97.64 per cent.

The material that passed through the 12-mesh screen was next sized on a 60-mesh screen. In this case the oversize was 28.5 pounds, or 26.9 per cent of the whole sample. The material that passed through the screen weighed 75 pounds and represented 70.6 per cent of the entire sample. The material finer than 60-mesh was found to be made up entirely of sand and was rejected.

The 28.5 pounds of material recovered between 12 and 60-mesh was passed over a concentrating table which resulted in the recovery of 10 pounds of brass. This represented 9.45 per cent of the original sample.

Recovery from Machine Shop Sweepings

The machine shop sweepings were treated in practically the same manner. In this test it was found that the material which did not pass through the 12-mesh screen weighed approximately 1/3 pound and consisted of long brass shavings and various foreign substances such as string and paper. The weight of this refuse matter was so small it was not taken into consideration.

The material that passed through the 12-mesh screen and remained on the 60-mesh screen, weighed 65 pounds and represented 46.75 per cent of the whole sample. Twenty pounds of this material was placed in a pan where the grease was burned off. This resulted in a ½-pound loss. Thus, the sample of material that went on the concentrating table weighed 19½ pounds. From this amount, 16.5 pounds of clean brass were recovered.

The grinding wheel dust was first passed through a 12-mesh screen and as only 2/3 pound of waste material was recovered, this amount was not considered in the test. The material was then passed through a 60-mesh screen and the amount that remained on the screen was 73.25 pounds, which represented 24 per cent of the whole sample. This material was found to yield 72 per cent of clean brass after passing over the concentrating table.

The material which passed through the 60-mesh screen weighed 262.5 pounds and represented 76 per cent of the original sample. It was found that this material yielded 35.6 per cent of clean brass on passing over the concentrating table.

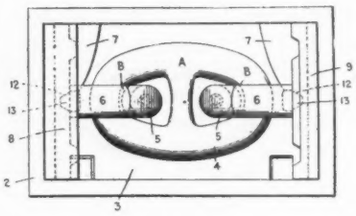


FIG. 1

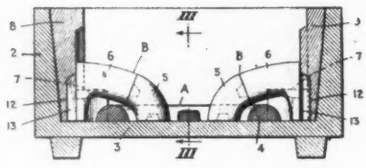


FIG. 2

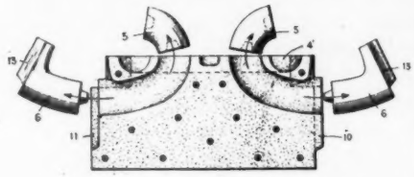


FIG. 3

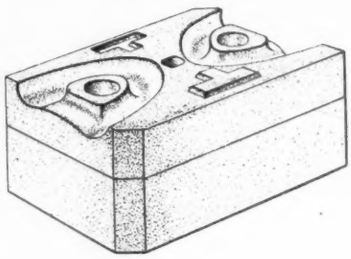


FIG. 4

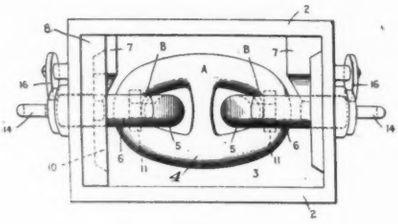


FIG. 5

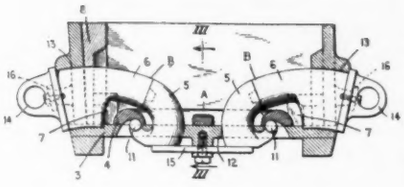


FIG. 6

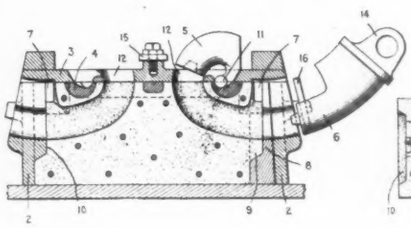


FIG. 7

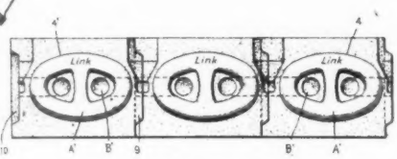


FIG. 8

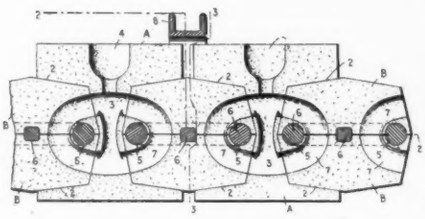


FIG. 9

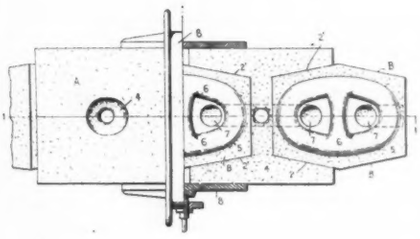


FIG. 10

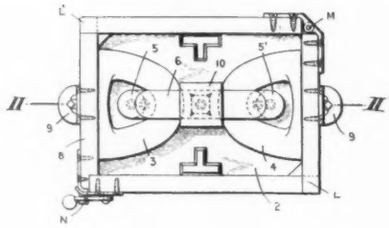


FIG. 11

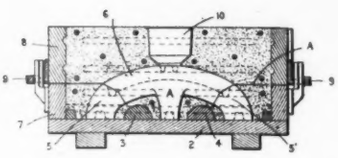


FIG. 12

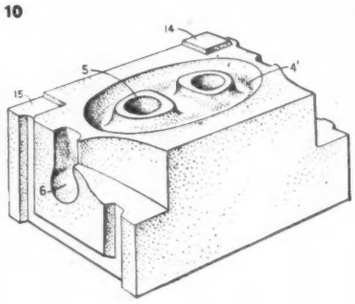


FIG. 13

FIG. 14

HOW THE METHOD OF MAKING CAST STEEL ANCHOR CHAINS WAS DEVELOPED

Figs. 1, 2, 3 and 4—The first method of making the molds. Figs. 5, 6, 7 and 8—The second method. Figs. 9 and 10—The third method. Figs. 11, 12, 13 and 14—The fourth method

MAKING CASTINGS OF UNIFORM THICKNESS FROM BLOCK PATTERNS

By H. J. Butler

The illustrations on Data Sheet No. 264 show a reliable method for producing castings of uniform thickness from solid patterns. The method may be applied to open work, such as heating stove tops, or to solid work, such as the oven doors of cooking ranges.

The first step is to make a wooden pattern of the shape and form desired. The face of this pattern is the same as that of a loose pattern of like design. At the back, however, the pattern is not hollowed out. This pattern is attached solidly to a board, as shown in the upper view on Data Sheet No. 264. This board is fitted with pins that fit the drag with which it is to be used.

When molding by this method, the drag is clamped to the board and the sand is rammed hard. This point is important and should not be overlooked. The pattern is drawn in the usual way.

The thickness of the casting section is determined by the thickness of clay that is used in the molding process. The clay is rolled out in sheets with an ordinary rolling pin, on a board having wooden strips on its sides. These strips are the same thickness as the section desired in the casting. The board is shown in the lower view on Data Sheet No. 264. It should be approximately 18 inches long and 6 inches wide while the strips can be of 1-inch material and of the same thickness as the casting section.

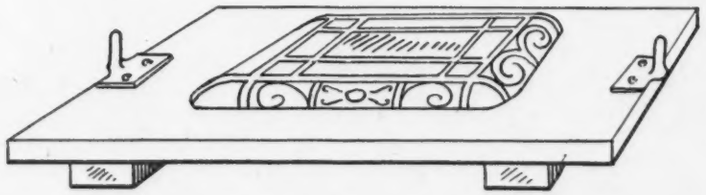
The mold is next lined with strips of clay cut from a sheet that is rolled out on the board described. This results in a lining of clay of a uniform thickness in the drag. The cope is rammed in the usual way, gated and vented and set aside. The clay is removed, the drag is shaken-out and a new drag is made on the pattern board, as would be done in ordinary practice. The mold then is closed and is ready for pouring.

Potter's clay gives good results in molds of this kind. It should be tempered with water firm enough to handle conveniently and preferably should be dusted with facing before rolling out on the board. It is also advantageous to varnish the rolling pin and the clay board as this prevents the clay from adhering.

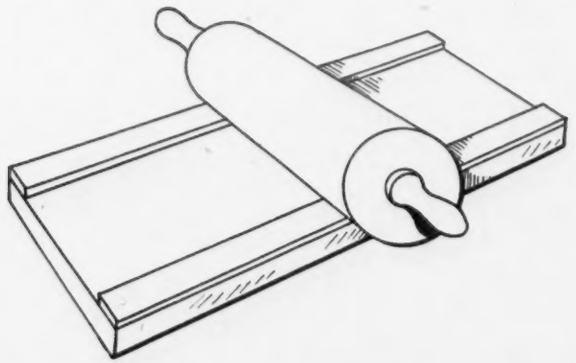
MAKING CASTINGS OF UNIFORM THICKNESS FROM BLOCK PATTERNS

By H. J. Butler

(Continued from Data Sheet No. 263)



BLOCK PATTERN ATTACHED TO BOARD



CLAY THICKNESS BOARD

THE FOUNDRY DATA SHEET, AUGUST, 1918

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

How Steel Anchor Chain is Molded and Cast

Two Processes Employed, Using Dry-Sand Molds—Chain May be Gated on Stud or Side of Link—Special Heat-Treatment Necessary

MORE details describing the methods of manufacturing cast steel anchor chain were presented at the June meeting of the American Society for Testing Materials, at Atlantic City. The successive steps in the new process leading up to the tests, the results of which were presented in the July issue of THE FOUNDRY, were explained by the experts who had charge of the experiments.

Developing the Process

Chester K. Brooks, assistant to the president, National Malleable Castings Co., Cleveland, referred to the initial problem, the working out of suitable foundry methods for producing chain links in sand molds and uniting them in continuous lengths. In part, he said:

"Connecting up the links into chain was accomplished in either of two ways, by the continuous process, in which the entire chain is poured from one heat into previously prepared and united molds, filling one interlinked mold impression after another and by the precast link process, in which half the links comprising a complete length of chain are cast separately, shaken out, cleaned, inspected, and made ready for incorporation into the finished chain. Subsequently, these links are placed in mold cavities and coupled up into continuous chain by pouring metal into other molds containing impressions for similar links, interlinked with the precast links.

"Another part of the foundry problem was the character of the mold. Recognizing the vital importance of sound castings in a product of this character, we came to the conclusion early in our experiments that all of the links should be produced in dry-sand molds. The methods of application of gates and risers also required some study. Eventually, however, we secured excellent results both by pouring through the stud and through the side of the link.

"In our annealing practice, the adaptation of the method of heat treatment used for our car coupler knuckles to 90-foot shots of chain has involved some problems, but these have been solved and the process will be practically identical in method and results."

Referring to the application of the new process to the solution of problems met with in the manufacture of car coupler knuckles, Mr. Brooks said:

"In the early days of our experiments we started making couplers by the acid open-hearth process, later changing to basic, but our experience with both these steels led us to believe there was no possibility of increasing the tensile strength sufficiently without loss of ability to withstand shock, which would only result in failure to withstand the required Master Car Builders' drop tests and which tended to compel the use of a very soft material. We then began a series of experiments in the electric furnace with high-carbon heat-treated steels and later with alloy steels. Marked improvements in tensile strength were the result but the ability to withstand shock did not increase, and in many cases was diminished. Finally, we arrived at a special material which combined with a high tensile strength a very extraordinary ability to withstand shock. This material, now used in our coupler knuckles, has raised their elastic limit more than 225 per cent, and their ability to resist shock stresses nearly 100 per cent over ordinary open-hearth steel. The amount of shock which these knuckles will take without breakage or serious distortion is beyond anything in our experience, and we have been able to develop a specification of our own, along the lines of M. C. B. coupler specifications, but calling for only half the amount of knuckle distortion with the same amount of shock in the drop test, a feature of the greatest advantage in the maintenance of proper contour in service.

Chain and Coupler Problem Compared

"There are so many points of resemblance between the coupler-knuckle problem and that of cast steel chain that we were able to start at a point which otherwise must have taken years of study and development. In our opinion, a proper specification for cast steel chain would require the making of links in dry sand molds or cores, but other details of manufacture should be left optional with the manufacturer. For the chemical requirements, the steel should be made by the electric furnace process, with phosphorus and sulphur limits of not over 0.04 per cent. The physical requirements should be sufficiently rigid to insure sound material, and should embody a dynamic test sufficiently severe to put the ability of the steel to withstand shock beyond any question of doubt. For this latter purpose we believe the standard M. C. B. drop testing machine presents the most readily available commercial machine."

In a further discussion of the molding practice adopted by the National Malleable Castings Co., Mr. Brooks stated that the alternate link method of casting now is being practiced. By this method each alternate link of the 90-foot shot of chain is cast separately from one heat of metal and these links are set into molds and the interlocking links are cast around them. These interlocking links are poured from another heat of electric steel, so that the entire shot of chain represents two heats.

A plan view of three abutting molds illustrating the alternate link method of molding is shown in Fig. 8 and a plan and end view of one of these molds showing the link cavity and method of gating is illustrated in Fig. 13. While each mold or core is made individually, these are butted against each other to constitute the entire 90-foot shot of chain. An earlier and more complicated method of molding, and which has been discarded, is shown in Fig. 9. It will be noted that by this method of molding one core interlocks into another, complicating the molding operation. A cross-section of a flask showing the arrangement of the pattern for the continuous method, is illustrated in Fig. 2. One method of drawing the pattern out of the mold or core is illustrated in Fig. 3. It will be noted that the pattern is divided into several pieces to facilitate drawing. Another method of drawing the pattern is shown in Fig. 6. Here the loose pieces are drawn out on a pivot and slide. Fig. 7 is a view of a mold with the loose pieces drawn out by the method shown in Fig. 6.

It was explained by one of the members that the twist and pull service test cannot be reproduced by the impact test. To ascertain definitelly what this chain will do under the most severe service conditions, a number of lengths will be tested by battleships.

Both Methods Satisfactory

H. Jasper Cox described the work done by the General Electric Co., to produce cast-steel anchor chain. He said:

"A number of successful molding and casting methods have been tried, by some of which alternate links are pre-cast and inserted in the molds before casting the connecting links, in others all links may be cast at one time, while other methods again are adaptable to either.

"A good deal of controversy has arisen regarding the respective merits of gating on the stud or on the side of the link, but it may be said that good links have been produced by both methods. The stud being the least important part of the link, any defect caused at the gate is not of the same importance as it would be on the side.

"It is considered most desirable that only dry-sand molds and cores be used to avoid as far as possible the tendency of piping in the casting, especially in the smaller links. The Na-

tional Malleable Casting Co. cast-steel links were subjected to the same heat-treatment as car coupler knuckles. In this treatment the links were placed on a traveller and slowly passed through a heating furnace in which the desired heat is automatically controlled by special contacting pyrometers. At the discharge end of this furnace the links are dropped into a quenching tank of water and after quenching are slowly passed through a drawing furnace on a second traveller.

"For the treatment of complete lengths of 15 fathoms of cable modifications in the arrangements of these furnaces and quenching tanks have been worked out by The National Malleable Castings Co."

"Stronger than Wrought Iron"

In a discussion of the papers read by Mr. Brooks and Mr. Cox, W. L. Merrill, General Electric Co., and chairman of the Testing society's subcommittee on ship welding, said:

"The General Electric Co. assumed that wrought iron has been and still is a satisfactory material, and that it would find a more sympathetic interest in chain having some approximation to the qualities of wrought-iron chain than in one whose physical characteristics are radically different from the commonly used material. Therefore, it set out to make a commercially practical composition of cast steel which, while it was easily cast into the necessary forms and sizes, would be soft and ductile. Softer or milder steels can be cast, but not quite so readily as the 0.30 per cent carbon steel selected. The required degree of ductility in such a steel may readily be obtained by simple heat treatment. The result is a steel not especially high in strength, although far stronger than wrought iron, having sufficient elongation and reduction of area to indicate a good degree of ductility. The average of the tests made on a great many heats would be about 35 per cent reduction and 21 per cent elongation. This metal, then, is not radically different from wrought iron in its tensile properties, while chain made from such steel is stronger than wrought iron chain. The General Electric Co. felt it had offered a good answer to the problem, namely, a cast chain stronger than and equally as tough as the wrought chain universally used."

Closing the Grain of Bronze Castings

By D. P. Falconer

In an interesting article in the July issue of THE FOUNDRY, a method of making close-grain hydraulic bronze was described. There is another method of obtaining the same result by using magnesium. The amount of magnesium necessary for this work is from 0.05 to 0.10 per cent. The magnesium may be introduced directly into the pouring ladle by plunging. Slow stirring should be continued after the magnesium has melted from the tongs, in order to give the magnesium oxide a chance to rise to the surface. When magnesium is used, no other deoxidizing agent is necessary.

The second method of introducing magnesium is by making a 10 per cent magnesium-copper alloy, which can be done by melting, say 45 pounds copper and adding slowly about 5⅛ pounds of magnesium. Not over ¼-pound of magnesium should be added at a time. Care should be taken to keep the magnesium beneath the surface of the molten copper, as otherwise it will burn, taking its oxygen from the air. This alloy can be poured in pigs which may be introduced into the ladle in such proportions as would give the required amount of magnesium. This gives a dense, strong metal and as the percentage of magnesium is small its use will cost less than phosphorus or phosphor-copper.

The first action of magnesium in an alloy of this kind is to deoxidize the metal, so that unless an excess is used, none of it will analyze in the finished product.

Varnishing Patterns to Suit Conditions

By M. E. Duggan

Many patternmakers, as a result of years of experience, become experts in finishing patterns. It is part of the trade to know how much finish to put on a pattern, since in many instances a high-grade finish is applied when a much cheaper finish would be satisfactory. Patternmakers who have had their training in jobbing shops waste little time in finishing since they know by experience approximately how much work should be done on every model that is produced.

During my apprenticeship I was taught that after the pattern is turned out it should be sand-papered and holes and cracks filled, either with beeswax or putty. However, it has been my experience that puttying, waxing, filleting, etc., are not so nearly essential as pointed out to me in my younger days.

The finishing process involves the application of two or more coats of spirit varnish which add to appearance of the pattern, increase its durability by imparting a surface not easily penetrated by water or moisture in the molding sand and it produces a smooth surface on the pattern so essential for its easy removal from the sand. A varnished pattern escapes much of the rough usage generally bestowed upon patterns in the foundry because the molder would not rap it as much as a pattern not so finished. A better finish is imparted by several thin coats of varnish than by applying thick coats. The first coat fills up the pores of the wood, fixes the fibrous projections left by the sand-paper, and after the first coat is dry, fine sand-paper is used to remove the fibers so fixed. The second and succeeding coat impart the gloss.

A patternmaker invariably mixes his varnish. The pots should be of stone or copper and not of iron, since the latter will discolor the varnish. To the shellac is added just a sufficient amount of alcohol to cover it and the mixture is stirred occasionally with a stick and not with a brush. Black varnish is made by adding dry lamp black to the clear varnish. The brush should never be permitted to touch the bottom of the pot, which should be kept covered when not in use. Patterns also may be varnished while running in the lathe and this also hastens drying. Occasionally also, varnish becomes milky in appearance and this is due to the use of a poor grade of wood alcohol or alcohol that perhaps may contain some water. I consulted a varnish maker regarding this phenomenon and he stated that varnishing, so far as possible, always should be done on a dry day. If there is considerable moisture in the air the varnish becomes chilled, that is, it assumes a soapy or milky appearance, evidently having absorbed water and for that reason the coating is spotted when dry.

Preventing Cracked Treads on Mine Car Wheels

Question.—We make mine car wheels weighing from 78 to 130 pounds. These wheels have from six to eight spokes and the treads frequently crack at the point where the spokes join.

Answer.—Your chill test pieces should tell you if your mixture is correct and an examination of the crack should also show whether your mixture gives you the chill you need. Your analysis shows 1.10 per cent silicon. You might lower the silicon as you seem to have too deep a chill. Your returned scrap is stated to contain 1 per cent silicon. This would show that your loss of silicon in melting is 0.22 per cent. You assume that your steel scrap contains 0.50 per cent manganese, 0.08 per cent phosphorus and a similar amount of sulphur. We would suggest leaving these out of consideration when figuring your mixture. Your chill test, however, is the best guide. Examine the depth of the chill and change your mixture accordingly.

The desirable properties of good brass valves are as follows: Ease of machining, ease of casting, strength and resistance to steam. The latter requirement frequently is determined by the use of the scleroscope or other similar testing machine, as hardness is an indication of the resisting power of the metal to the action of steam.

Patternmaking and Molding Cast Tooth Gears

The Practice of a Generation Ago is Contrasted With That of Today and This Gear-Molding Machine is Briefly Discussed

By Jabez Nall

WHILE gear-cutting machinery has made big inroads in the cast gear industry, nevertheless, for many purposes, these gears serve the purpose admirably and this branch of the founder's art never will be entirely superseded by machinery for gear work. A generation ago a patternmaker's skill was measured by his ability to make an accurate gear, but pattern shop practice today, in the production of gear models, differ considerably from that of 20 years ago. At that time it was the custom to dovetail the teeth into the rim of the wheel. Sometimes this was accomplished by turning off the rim to the diameter at the back of the dovetail and the tooth block was prepared in wedge form with beveled edges as shown in Fig. 1, a filling-in piece having been used as indicated, thereby forming the dovetail. Both the dovetails and the teeth usually were made from hard wood. This method of making the teeth always insured a smooth surface with the grain in the direction of the draft of the pattern. This, of course, always was a desirable feature whenever practicable, yet it entailed considerable additional work and the teeth were liable to become loose from the repeated swelling and shrinkage of the lumber as the pattern was used more or less in the foundry.

A Preferred Method

Another method which was preferable consisted of turning the rim of the wheel to the diameter at the root of the tooth, the female half of the dovetail having been planed out by a plane especially designed for this work. The dovetail, which was made separate from the tooth, first was fitted and the tooth block was glued onto this. Subsequently, when removed, the dovetail was further secured by nails or screws. If the tooth block was cut with a small allowance of stock for finishing, it usually was considered advisable to insert wedge-shaped pieces to prevent splintering or other accidents while turning the ends of the teeth. Such wedge-shaped inserts are shown at A, Fig. 1. However, to avoid doing this it was the practice of some patternmakers to cut the tooth blocks wider and to champfer off the back edge. However, the time required for doing the work by both methods was about equal. After the tooth blocks were in position with the face and ends turned to size, the pitch line was marked. If each tooth was to be laid out by compass, which was done only when the wheel contained a small number of teeth, the lines for the bevel of the centers of the curved faces of the teeth also were marked, care having been exercised to make these lines as fine as possible. It was also the practice to prepare a template of the layout of the end of the tooth upon a piece of sheet zinc or heavy tin plate. This was attached to a piece of wood cut to accurate dimensions and was passed around the face of the wheel. This template was applied in accordance

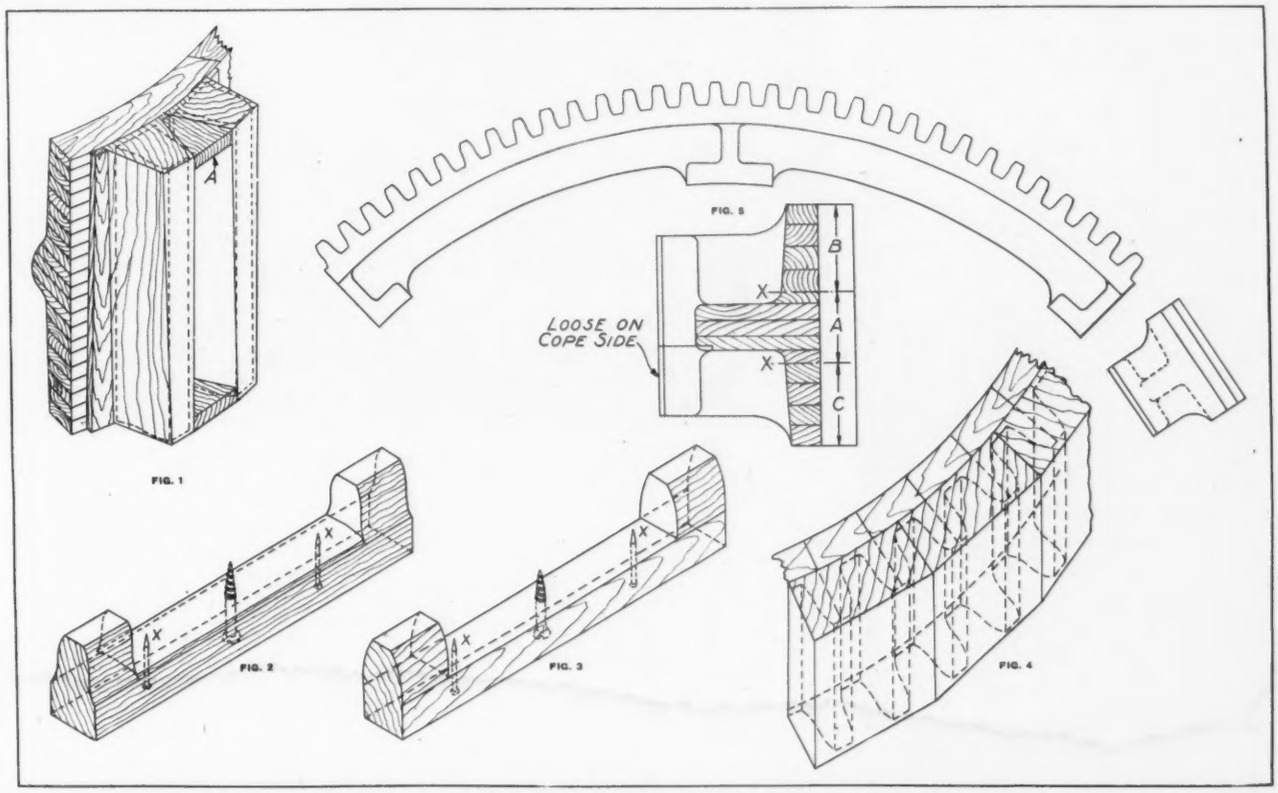


FIG. 1—METHOD OF DOVETAILING PATTERN TOOTH BLOCKS TO THE RIM OF A WHEEL; FIGS. 2 AND 3—JIGS USED FOR FORMING THE PATTERNS FOR GEAR TEETH: FIG. 4—TEETH SKETCHED ON RIM OF WHEEL; FIG. 5—SEGMENT GEAR PATTERN

with the spaces previously indicated in the pitch line and marked with a fine scratch awl, each tooth subsequently being taken off and worked separately by hand according to the lines thus made. Therefore, it was necessary to dovetail the teeth in order that they might be accurately replaced.

This and other methods of making gears required skill on the part of the patternmaker. However, most of the methods outlined long have been discarded, not because they did not produce results, but because they involved too much labor and the cost of production was too great. Even a generation ago the method of forming the teeth in a jig was not new, but many patternmakers at that time questioned the accuracy of a gear thus made. Judging from my own experience in checking up patterns made in this way at different times, the patternmakers of that day had good reason to question the accuracy of this method. However, this reference is not to be construed as condeming a method that has become almost universal and which I believe gives equally as accurate results as the old hand methods in vogue years ago. To insure accuracy in making patterns for gears, skill and care are essential.

FIG. 6—METHOD OF FINISHING TOOTH BY SAND-PAPERING ON A LATHE

Types of jigs used are shown in Figs. 2 and 3. The tooth blocks which previously have been cut to length, fit snugly between the ends of the teeth and are held in place at X-X; they also are secured by wood screws at the center. The teeth usually are planed off by hand; if many have to be finished in this way, the operation, it is evident, becomes very tedious. If the teeth are of the involute type or one-curve face, the planing operations may be speeded-up considerably by clamping the plane in a vise and by arranging a stop at each end of the stroke thereby preventing injury to the jig by planing too far. The teeth next are finished by sandpapering either on a grinding machine or on a lathe, the later method being illustrated in Figs. 6 and 7. It is claimed that by the use of jigs absolute accuracy in producing the teeth is insured and furthermore, that each tooth model is a counterpart of the other. However, according to my experience this depends largely upon the skill and care exercised by the patternmaker in the construction of the jig and sanding roller.

As a criticism of the accuracy of this method of making gear teeth I will point to my experience with a 30-tooth pinion, 3½-inch circular pitch. The work of making this pattern was given to a skilled patternmaker and after checking the first tooth made and finding it correct, I paid no further attention to the job until the teeth were finished. Before they were placed on the wheel, however, I compared the last tooth made with the first one produced and found it to be 1/16-inch less in thickness and somewhat irregular. Investigation showed that the patternmaker had used a roller too short for the jig and it had worn away sufficiently to cause the difference in size. After considering the probable results of the use of such a pattern in the foundry I decided to make all teeth of the smaller size and had the jig corrected to these dimensions. A new sandpaper roller or drum was prepared and the teeth finished the second time with the result that they were practically correct according to the jig. The resultant castings more than confirmed my judgment, as the slightly reduced difference in thickness was more than made up in the foundry. The method of forming gear teeth, illustrated in Figs. 6 and 7, can be applied either to beveled or straight teeth, but for teeth of the involute or one-curve type, better time and a more accurate job can be made on a disc grinder with a properly arranged jig, which has proved satisfactory for this work. With the teeth correctly formed and the rim accurately spaced great care must be exercised in placing the teeth on the rim. Each tooth should be tested by calipers as it is glued in position. Probably the ultimate test for the accuracy of the gear pattern was devised by the foreman of a pattern shop who made a plaster cast of the space of three teeth and applied this to different points of

FIG. 7—THE SAND-PAPER ROLL ON THE LATHE IS CLEARLY SHOWN AND THE OPERATOR IS TESTING THE CURVATURE OF THE TOOTH PATTERN

the wheel. A pattern that would meet this test could be considered to be nearly perfect.

Gear teeth also are shaped by the band saw. Briefly stated, the method consists of revolving the wheel upon a ball surface through the center of which the saw passes. The lines are laid out on the large ends of the teeth only. The patternmaker, therefore, only has to follow the lines with the saw, the cutting point of which is radial to the axis of the gear. While I always believe in band-sawing to the line in patternmaking generally, I was skeptical about this method of finishing gear teeth. However, the results surprised me and while band-sawing may not be considered the ultimate of perfection, nevertheless it is practical and a satisfactory finish is given with a limited amount of sandpapering.

The method of making gear teeth for wood patterns that gives the best results in time cost and accuracy is to block the teeth full size on the rim as shown in Fig. 4, and to cut them with specially-prepared cutters on machines particularly designed for this class of work. Such machine-cut teeth will vary less than hand-made teeth and machine indexing will insure accurate spacing and uniform teeth.

FIG. 8—GEAR-MOLDING MACHINE ON WHICH THE TOOTH BLOCK IS STATIONARY AND THE MOLD REVOLVES

A quarter segment of a built-up spur gear, having a 15-inch face, 3½-inch pitch and a pitch diameter of 142½ inches, is shown in Fig. 5. While the construction of this pattern involves the same methods as that of building a full wheel, patternmakers frequently experience considerable trouble in getting the segments correct, partly owing to the lack of proper facilities for doing the work and also, in a measure, in approaching the task by the wrong method. If the pattern for a segment as large as this is to be made accurately, great care must be exercised in its construction and the principal difficulty against which every precaution should be taken, is to avoid twisting the face of the segment. This can be done unwittingly if the patternmaker is content to square only from the narrow face of the segment. A surface plane should be used for squaring purposes, but not all pattern shops have this essential tool. In the absence of such a tool other means, such as sighting from parallels held on vertical lines may be employed, and whatever means the patternmaker uses to square up the face, he should be sure that it is correct before the teeth are placed.

Fig. 5 also shows a cross-section of the segment pattern. When building it the web *A* should first be turned out correct as to thickness and outline and then should be braced level. Parts *B* and *C*, then are built onto this with dry joints at *X*. This permits the removal of sections *B* and *C* in order that they may be cut to line on the band saw with the table tilted to give the required taper.

Another feature to consider in the construction of these patterns, which usually is not apparent until the segments are assembled in the machine shop, is the effect of contraction of the casting. These castings usually are made of steel and invariably will straighten somewhat when cooling, particularly with the flanges on the ends as in this case. This segment straightened about 5/16-inch, which was provided against by increasing the curvature of the pattern.

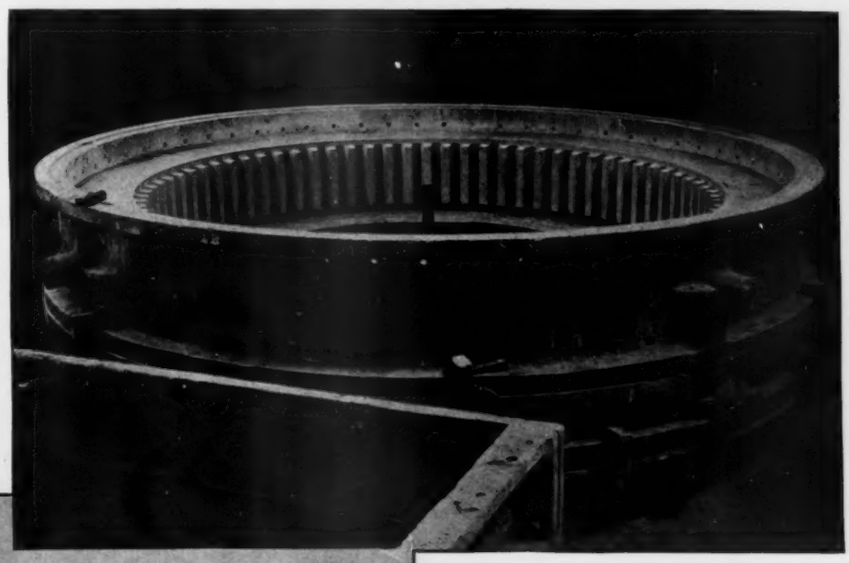


FIG. 9—MACHINE-MADE GEAR MOLD BEFORE CORING

A gear molding machine with a tooth block in operation on a shrouded pinion is illustrated in Fig. 8. In this view one tooth space has been completed and the block is being adjusted for the next. The tooth block is attached to a slide that can be raised or lowered, as required, in ways at the end of an extended arm that is counterbalanced and swings in either direction. For gears of larger diameter, the flask is held stationary and the table is revolved. A bracket with slide attachments, both vertical and horizontal, carrying the tooth block is bolted to the table and the teeth are formed in a manner similar to that shown in Fig. 8, except that in this instance the tooth block is revolved from space to space, whereas in Fig. 8 the tooth block center is stationary, the mold revolving. By a system of change gears any number of teeth may be spaced, but in spacing care must be exercised to prevent over-running the stop pin as otherwise any lost motion in the machinery would change the spacing.

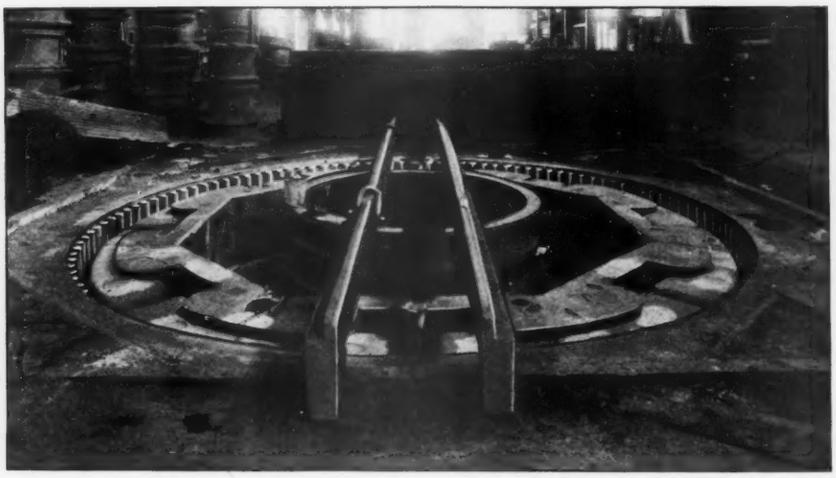


FIG. 10—LARGE GEAR MOLD MADE IN TWO HALVES. THE CORES ARE IN PLACE

In Fig. 9 a machine-molded gear is shown ready to receive the cores. Fig. 10 is a view of a large gear, 18 feet 6 inches pitch diameter, molded in two halves. This gear has a 27-inch face. The setting of the cores is clearly illustrated. Fig. 11 shows a machine-molded cast steel gear poured in a mold similar to the one illustrated in Fig. 10. The casting, however, is considerably smaller in size than the one that was poured in the mold in Fig. 10.

A straight face spur gear, just after shaking-out, is illustrated in Fig. 12. This shows the method of gating from the center sprue. The metal flows through six channels and enters the mold underneath the rim at two points, *A* and B. The six risers, of generous size, indicate the care that was exercised to produce a solid casting. Also, a smooth surface on the teeth is indicated by the ease with which the sand has peeled off.

Repairing Manganese Bronze by Burning-In

Defects in large manganese bronze castings frequently are removed by burning-in, a process well-known to all brass founders. This method, however, sets up strains in the casting which frequently relieve themselves by ultimately forming cracks. These strains can be avoided by heating the casting uniformly all over before the burn is made. This is seldom done, or if it is, it is accomplished in a perfunctory manner. The casting should be heated until it is a dull red, at which temperature internal strains not only will be eliminated, but the burn will *take* with much greater certainty and with the expenditure of considerably less molten metal.

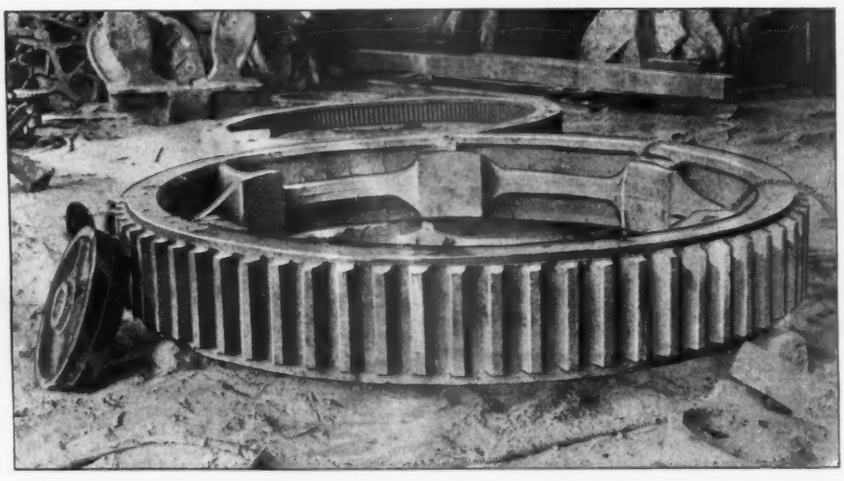


FIG. 11—LARGE CAST STEEL GEAR

Lead in Copper-Tin Alloys

Lead is not introduced into copper-tin alloys to secure strength, but to improve the machining qualities of the alloy. Lead is used in alloys for bearings because it greatly improves the antifriction qualities of the alloy. The lead content may vary from 5 to 30 per cent, and the alloys containing the higher percentages of lead are known as plastic bronzes because they are supposed to adapt themselves to inequalities of the shaft better than the more rigid bronzes. The great disadvantage of the rigid bronzes, that is the bronzes containing little lead, is their lack of plasticity. They do not mold themselves around the shaft to compensate for poor fitting. Even in a comparatively well adjusted bearing, one or two parts will be higher than the average surface, and it is on these that the load will be carried with consequent excessive local pressure which may lead to cutting and intense heating at these points. The surface is worn even at the expense of deterioration of the shaft or axle, leading to a constant source of heating in the bearing.

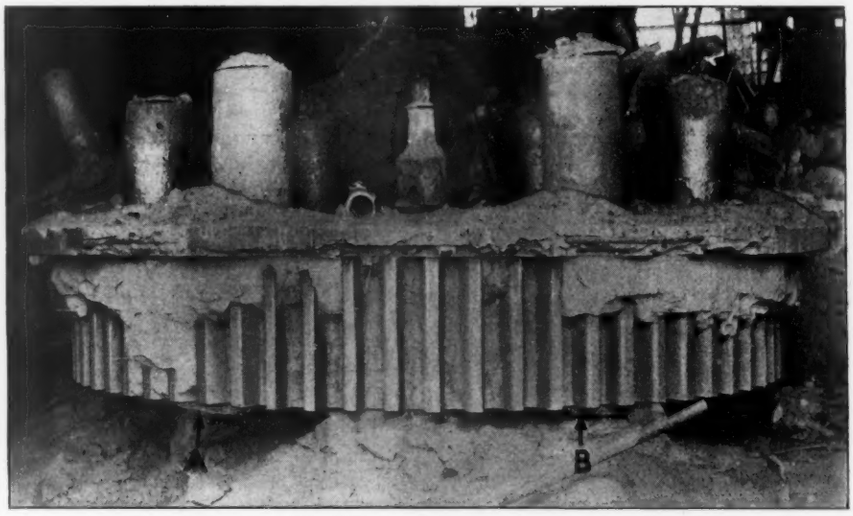


FIG. 12—LARGE STRAIGHT FACE SPUR GEAR BEFORE CLEANING AND AFTER SHAKING-OUT OF THE MOLD

A flux for use in welding or soldering aluminum and its alloys consists of a borate and an alkaline bisulphate having a lower melting point than aluminum. An example is borax 96 parts, sodium bisulphate 4 parts.

Advantages Offered By the Oil-Fired Cupola

In the Process Described Crude Oil is Sprayed Directly Onto the Coke Bed to Increase the Heat and to Reduce the Amount of Coke Consumed

By W S Dickson

THE question of using fuel oil in the foundry cupola first occupied the attention of Bradley Stoughton, of the Stoughton Process Corp., New York, in 1909. The process consists of using crude oil in conjunction with a materially reduced amount of coke. This reduction depends on the results desired. The process is easily carried on as no complex mechanism is necessary. Fig. 2 is an elevation of an oil-burning cupola, while Fig. 3 is a plan view of the same installation. In the type of cupola commonly used, the windbox encircles the tuyeres. If the windbox has sufficient depth, it is a simple matter to place the high-pressure crude oil burners inside. With this type of cupola, a standard plate, which is made in two sections, can be used. One plate is bolted to the windbox while the other is removed only in case of emergency which requires inspection and removal of the burner. It is advantageous to have the air supply line as near the cupola as possible. From 80 to 100 pounds pressure has been found to be satisfactory while the pressure in the oil supply line should be from 40 to 50 pounds. When the supply lines are located near the cupola it is a simple matter to run branch lines from them and to include the necessary strainers, drips and meters. Pressure regulating devices should be installed in cases where the pressure is liable to vary or where the initial pressure exceeds the figures given.

By referring to Fig. 2 it will be noted that auxiliary piping for both air and oil leads to each burner. These lines are made of flexible metallic tubing. The object of the high-pressure air is to atomize the oil, this function being readily controlled at each burner by means of individual valves.

As all the attachments are of a simple nature the time required to make a complete installation seldom occupies over two days. If the fire brick lining of the cupola is in good condition it is seldom necessary to make extensive alterations, but it is sometimes advisable to enlarge the tuyeres to provide space for the burners. If this were not done, the quantity of air entering the cupola would be retarded. The cost of a complete installation on a 48-inch cupola in cases where the air and oil connections are readily installed should not exceed $635. In cases where the air contains much moisture it has been found advisable to install a separator and a trap to discharge the water.

In charging the cupola the usual amount of coke is placed on the bed. This bed, however, is not burned to produce heat utilized in melting. At the level of the tuyeres the burning mixture of atomized oil is injected. The intense heat comes in contact with the red hot coke bed and it is this added heat that is used in melting the cupola charge.

Experience has proven that the degree of heat can be regulated by adjusting the oil and air valves. The whole procedure is simple and does not require the services of an expert operator. Small additions of coke are made with each charge of iron. As only a fraction of the usual amount of coke is used it is apparent that the greater part of heat is generated by the oil.

Among the advantages claimed for the process are economy of operation, better control of melting and cleaner iron. By reducing the amount of coke, it is possible proportionately to reduce the oxidizing blast owing to the fact that only enough free air is admitted to produce slight combustion of the coke charge. The reduction of the amount of coke burned also permits of a corresponding reduction in the limestone used to flux the coke ash. This makes it possible to reduce the labor cost of handling the raw material. The chief advantage gained, however, is the reduction of sulphur for, as foundrymen realize, the absorption of sulphur is due to the coke giving up this element in the uncombined state, direct to the molten iron. Where the greater amount of heat is derived from the combustion of oil, however, the sulphur content of the oil is not a serious factor as it is oxidized before reaching the melting zone and passes off with the escaping gases in the form of sulphur dioxide.

The use of oil permits of a ready control of the heat generated in the cupola. As the major part of the heat comes from the oil, any variation in the amount used in a given time will vary the temperature. This factor can be taken advantage of to increase or decrease the capacity of the furnace and at the same time it insures hotter metal

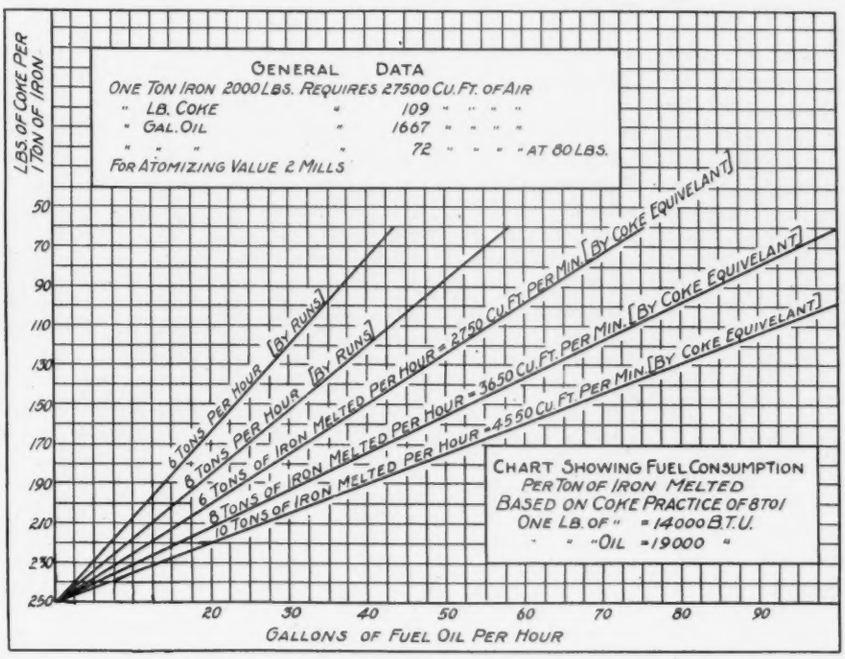

GENERAL DATA
ONE TON IRON 2000 LBS. REQUIRES 27500 CU. FT. OF AIR
" LB. COKE " 109 " " " "
" GAL. OIL " 1667 " " " "
" " " " 72 " " " " AT 80 LBS.
FOR ATOMIZING VALUE 2 MILLS
LBS. OF COKE PER TON OF IRON
50
70
90
110
130
150
170
190
210
230
250
6 TONS PER HOUR [BY RUNS]
8 TONS PER HOUR [BY RUNS]
6 TONS OF IRON MELTED PER HOUR = 2750 CU. FT. PER MIN. [BY COKE EQUIVELANT]
8 TONS OF IRON MELTED PER HOUR = 3650 CU. FT. PER MIN. [BY COKE EQUIVELANT]
10 TONS OF IRON MELTED PER HOUR = 4550 CU. FT. PER MIN. [BY COKE EQUIVELANT]
CHART SHOWING FUEL CONSUMPTION
PER TON OF IRON MELTED
BASED ON COKE PRACTICE OF 8 TO 1
ONE LB. OF " = 14000 B.T.U.
" " OIL = 19000 "
20
30
40
50
60
70
80
90
GALLONS OF FUEL OIL PER HOUR

FIG. 1—HOW TO CALCULATE THE AMOUNT OF OIL TO USE

Abstracted from a paper presented at a recent meeting of the Associated Foundry Foremen of New York and vicinity.

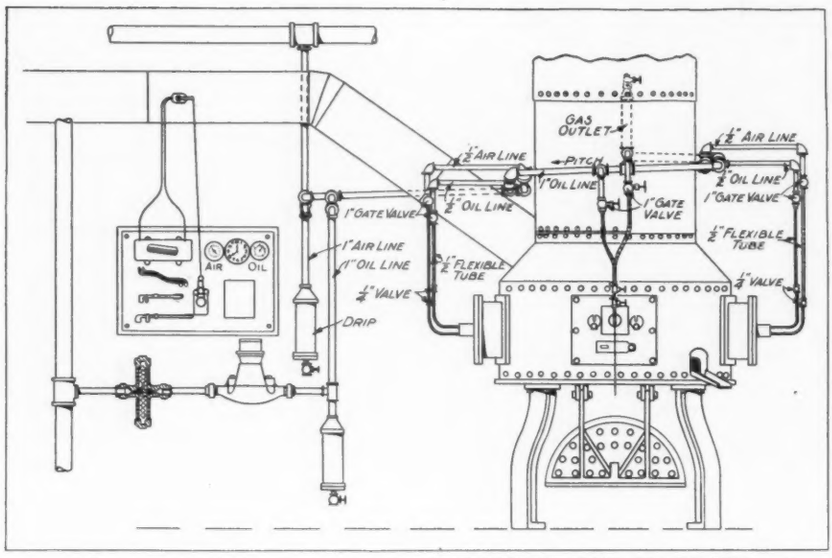


FIG. 2—ELEVATION OF A CUPOLA ARRANGED FOR OIL-FIRING

on the hearth. The use of oil also lessens fouling at the tuyeres for the entrance is kept clear for the air draft. Also, less limestone is required for fluxing. This results in a smaller amount of slag and thereby reduces heat losses.

Fig. 1 shows how to calculate the quantity of oil necessary when a given amount of coke is used. The lower three lines represent quantities, more or less theoretical, as they are based on a coke ratio of 8 to 1.

Running Test Heats

When test heats are run over a given period an engineer's report is filled out which contains the detail figures taken during the combined oil and coke heats. Comparative figures from runs where coke only is used also are included in the report. Among the most interesting figures are those of the iron and coke ratios which indicate the possible sulphur reduction. This coke ratio includes the coke bed and it is this figure that is compared with the quality of iron to coke equivalent. By coke equivalent is meant the fuel value of the oil consumed, computed in terms of coke. The b. t. u. ratio in the oil is ascertained and compared with the heat value of the coke.

Building a Cupola of Small Capacity

By W. J. Keep

Question:—We desire to build a cupola which is to be lined to 28 inches. Kindly furnish the necessary information regardng its construction.

Answer:—The bottoms of the tuyeres should be 13 inches above the top of the sand bottom or 17 inches above the cupola bottom. The tuyere openings on the inside of the furnace should be as nearly continuous as possible. At the rear of the cupola and opposite the tapping spout, leave a 6-inch space in which a slag tap hole should be cut, 1½ inches below the tuyere at the center of this space. The inside dimensions of the six tuyeres should be 10 x 3 inches. The bottom of each tuyere should be inclined upward toward the shell and the opening through the shell should be about 5 inches square. The wind box is built around these openings with a tight fitting shutter on the outside wall opposite each tuyere, approximately 6 inches square. Such a cupola should melt 2 tons of iron per hour. A No. 6 fan blower should furnish 825 cubic feet of air per minute operating 3456 revolutions per minute. A No. 7 fan blower at 3092 revolutions per minute should furnish 1125 cubic feet of air per minute. The blast pressure should be about 8 ounces. It is always advisable to make the cupola slightly larger than required.

In building a 28-inch lining, stock bricks should be used and these should be set on end. This would necessitate a shell about 37 inches in diameter. However, the shell should be about 45 inches in diameter and a lining of red brick can be placed next to the wall. At any future time, therefore, the red brick could be laid flat, making a 30-inch lining, or the red brick could be taken out entirely, increasing the inside diameter of the cupola to 35 inches. It is advisable to install a No. 7 blower which would melt four tons of metal per hour with a cupola lined to 30 inches.

For furnace grates, the silicon in the mixture should be about 2.50 per cent. You can use an all-scrap mixture and increase the silicon to the required percentage by the addition of a 7 per cent silicon pig, or you can obtain foundry pig iron containing about 3 per cent silicon. If you use this grade of foundry iron your charge should consist of half pig and half scrap.

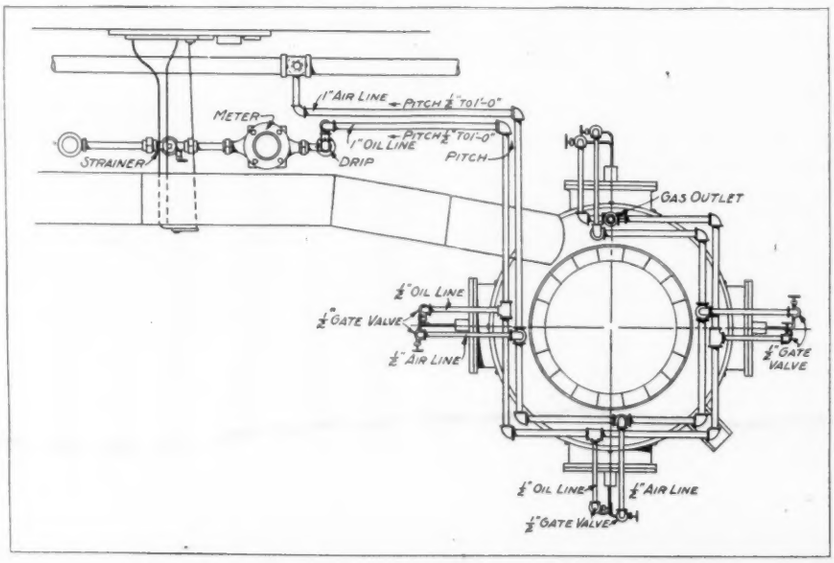


FIG. 3—PLAN VIEW OF THE CUPOLA SHOWN IN FIG. 2

The Effect of Zinc and Phosphorus in Alloys

Zinc and phosphorus in bronze act the same as silicon and carbon in steel. Zinc and phosphorus produce brittleness in the copper-tin alloys and, therefore, they should not be used together. Any two elements that act in a similar manner, if combined, usually will produce a greater effect than the sum of the effects of the two elements used singly. For this reason, when phosphorus and zinc are used together, comparatively small amounts should be employed.

Making a Pattern For a Gas Engine Cylinder

The Construction of the Core Boxes Also is Described and Two Methods of Molding Are Discussed, With Necessary Pattern Changes

By Frank B Raebig

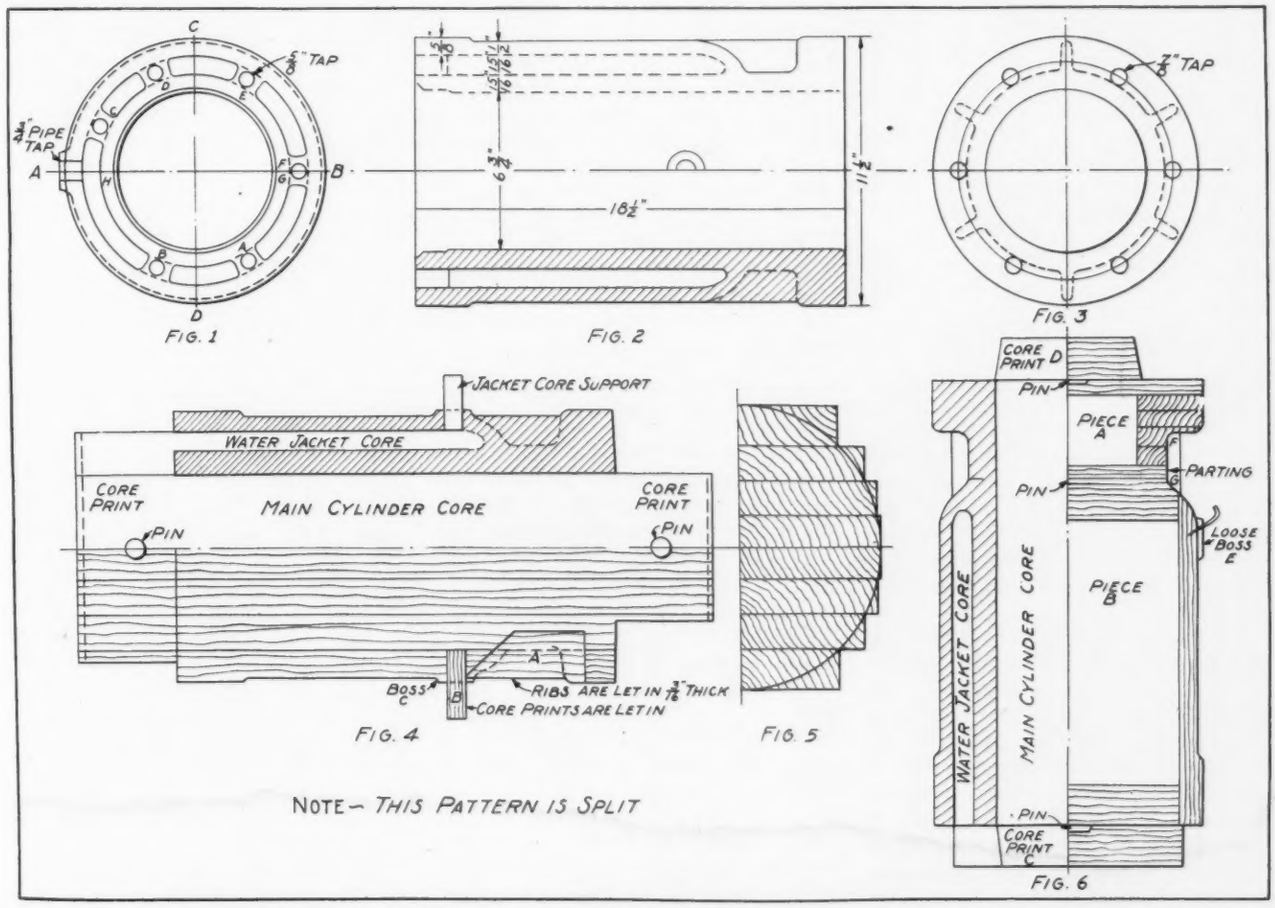
IN THE January issue of THE FOUNDRY the writer described the construction of a gas engine piston pattern, and in this article he will discuss the production of a gas engine cylinder pattern and will describe two methods of molding it. Both the piston and cylinder were designed for a horizontal gas engine. The cylinder is shown in Figs. 1, 2 and 3 after it has been machined and is ready to be assembled. Fig. 1 illustrates the water jacket end, Fig. 2 is a half plan and a half longitudinal section and Fig. 3 is the flange end of the cylinder.

In considering the molding of this pattern two methods are suggested. The most apparent and easiest, from the patternmaker's point of view, consists of splitting the pattern longitudinally, as shown in Fig. 4, and molding it in a two-part flask. The method suggested in Fig. 6 involves much more pattern work and necessitates a three-part flask.

Before determining the method of molding and pattern construction, three important factors must be considered. First, is it to be a standard pattern, that is, will many castings be made from it, or only one or two? Second, will time be saved in the foundry by making it as suggested in Fig. 6? Third, will the additional time spent in the pattern shop be compensated for by the time saved in the foundry?

The first question ordinarily can be answered with little difficulty. The second and third can be answered only approximately, and then only as a result of a conference between the molder and patternmaker. To arrive at an accurate conclusion would involve the data obtainable from an intricate cost system. This also would necessitate construction by the two methods for purposes of comparison. As this would not be desirable, except under certain conditions, the decision would depend on the approximate conclusions arrived at by the molder and patternmaker and the accuracy of these would depend largely on their general experience. This largely accounts for the differences of opinion between molders and patternmakers as to which is the most efficient method of molding certain patterns.

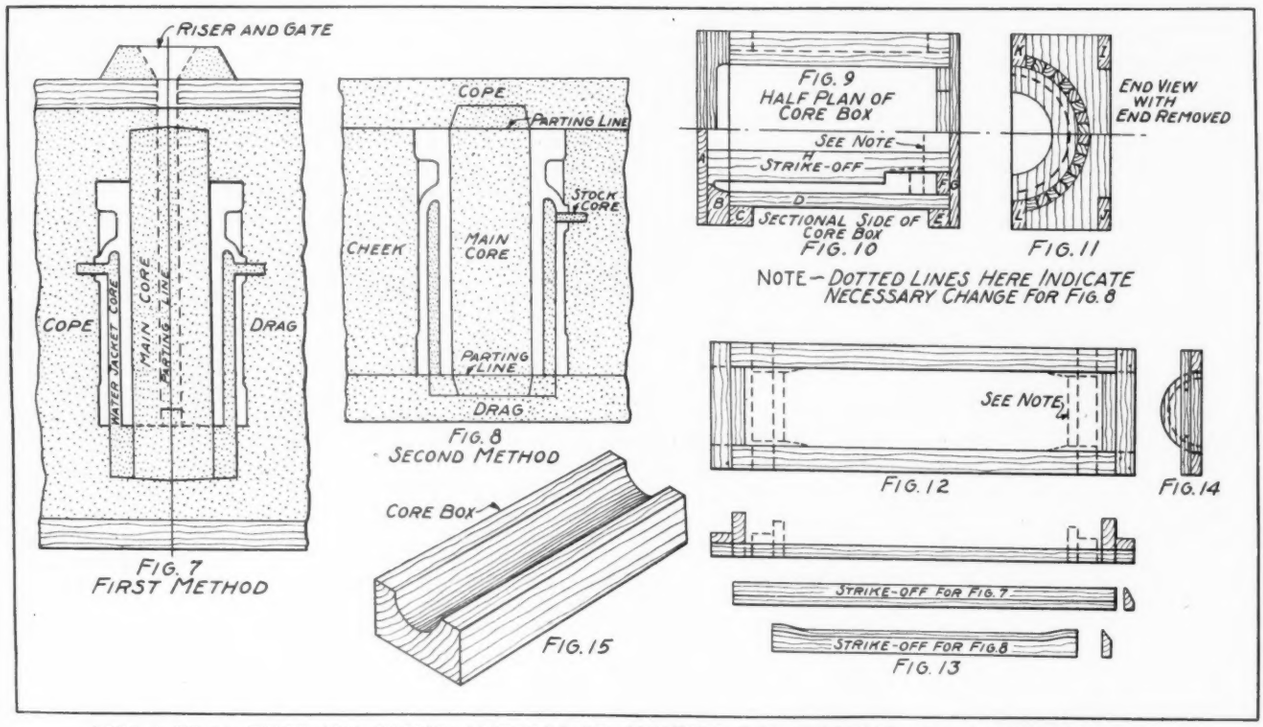
We will now consider molding the pattern as suggested in Fig. 5. It will be necessary to cast the cylinder on end to insure a clean casting. It is obvious, therefore, that molding it with the pattern constructed, as shown in Fig. 4, it will be necessary to turn the flask on end after it is molded so that the mold



FIGS. 1 TO 6—GAS ENGINE CYLINDER, SHOWING WATER JACKET END, HALF PLAN AND HALF LONGITUDINAL SECTION AND FLANGE END OF CYLINDER. METHODS OF MAKING THE PATTERN ALSO ARE ILLUSTRATED

will be in the position shown in Fig. 7 when cast. This method involves additional labor and handling with the attendant possibility of damaging the mold.

All these disadvantages are overcome by the second method, Fig. 8. The first method is satisfactory, providing only one or two castings are to be made, as the additional labor in the foundry offsets the added pattern labor required to make a model, as shown in Fig. 6. With the pattern constructed, as illustrated in this view, the problem of molding is simple. It involves the use of a three-part flask and with the exception of the two core prints the entire pattern is molded in the cheek. This method eliminates the unnecessary handling and labor required by the first method and reduces the setting of cores to a simple operation. The time saved in foundry labor by this method more than offsets the additional pattern labor, particularly if it is a standard pattern and many castings are to be made from it.



FIGS. 7 TO 14—FIRST AND SECOND METHODS OF MOLDING THE CYLINDER AND CORE BOX DETAILS

The construction of the pattern and core boxes shown in Figs. 4, 5, 6, 10, 11, 12, 13, 14 and 15 will be next considered. Fig. 5 shows the most practical method of glueing the stock for the two halves illustrated in Fig. 4. The two halves are fastened together and turned in a lathe to obtain the exterior form, Fig. 4. When the halves have been turned they are taken apart and pieces to form the boss, *C*, are fitted and fastened to each half. While only one boss is shown on the finished casting, two are put on the pattern to provide sufficient metal to screw in a plug when it reaches the machine shop. It is advisable to have two water jacket support prints instead of one, to facilitate setting the core and to provide an opening for the vent. The four semicircular pieces for these prints then are fitted and fastened in place, as shown in the lower half of Fig. 4. Pieces, *A*, 3/16 inch thick, or one-half the thickness of the ribs, are next cut to form, as shown in Fig. 4, and are fastened in position. These provide for the two ribs which lie on the parting line. The remaining four ribs are fitted and spaced equally around the circumference so that they are 60 degrees apart and are held with loose pins during the process of molding, being withdrawn from the mold after the main portion of the pattern has been removed. The dotted lines on the core prints in Fig. 4 indicate the draft given the ends. This concludes the construction of the pattern with the exception of adding the fillets and applying the shellac.

Pattern for Second Method of Molding

By referring to Fig. 6, it will be noted that the pattern for the second method under consideration consists of pieces *A*, *B*, *C*, *D*, *E*, *F* and *G*; *D* and *C* are core prints; *A* and *B* form the main body of the pattern; *E* is the loose boss; *F* and *G* form the ribs and are permanent on *A*.

When constructing this pattern, part *B* should be made first for obvious reasons. This section consists of two heads on the circumference of which staves are nailed and glued. These staves can be cut to the line by the rip saw and little if any fittting is required. After this part has been built-up, it is turned to conform to the shape shown in Fig. 6. On the drag end of *B* a pin is turned which centers it on the drag core print, *C*; on the cope end of *B* a recess is turned to permit *A* to be located centrally on *B*; on the cope end of *B*, six pieces, *G* are fitted and fastened to form a portion of the six ribs on the flange end.

Part *A* of the pattern next is made. It consists of an upper and lower circular disc and four courses of segments built-up and turned to conform to Fig. 6. On the lower side it is provided with a pin or ring to fit the recess in *B* and on the upper side it has a recess for the pin on core print *D*. After this has been turned, pieces *F* should be fitted around the circumference so that they coincide with *G* on *B*. These pieces form the ribs of the flange end. Another pin is provided on the lower side of *A* to prevent the ribs from getting out of alignment.

The core prints *D* and *C* are then turned and fitted to *A* and *B*, respectively. Core print *D* has a pin which corresponds to the hole in *A* and core print *C* has the hole which corresponds to the pin on *B*. The loose boss *E* then is fitted to *B* and is fastened with a loose pin. For this purpose brads, bent as shown in Fig. 6, are satisfactory.

As there is essentially no difference in the construction of the core boxes by both methods, they are shown with one set of illustrations and the slight differences are pointed out. The shapes

of the main cylinder and water jacket cores are shown in Figs. 7 and 8. The main core in Fig. 7 is about 4 inches longer than the one in Fig. 8, and the ends are not tapered in Fig. 7 as they are in Fig. 8. These are the only differences in the main core. Likewise the water jacket core is shorter by about 2 inches in Fig. 8 than in Fig 7 and in Fig. 8 it tapers on the inside lower end while in Fig. 7 it is straight. Although in both instances it could be straight on the drag end, yet it is better tapered. The taper on the drag end in Fig. 8 helps to secure the water jacket core and prevents the jacket core from lifting while pouring.

Main Cylinder Core

The main cylinder core can be made either with the frame and strike-off, as shown in Figs. 12, 13 and 14, or with the full half core box shown in Fig. 15. The latter method is the best. Three views of the frame are shown. It consists of two side and two end pieces, with two circular heads, including the strike-off. For both methods of molding the two cross pieces are the same, although there is a slight change in the side pieces. For the first method the diameter of the semicircular heads is the same as the diameter of the core, and by the second method the diameter is the same as that of the cope core print, shown in Fig. 8. Dotted lines on the Figs. 12, 13 and 14 indicate the necessary changes. To construct the frame, the two cross pieces are screwed and glued to the side pieces, the distance between them corresponding to the diameter of the core in both instances. To these cross pieces are fastened the circular heads.

Fig. 15 shows the half core box with the ends removed. This device does away with the frame and strike-off and is preferred by most coremakers. To construct this box a block of sufficient thickness and width is glued-up so that it will leave at least 1½ inches of stock outside of the core diameter. The semicircles are laid out on both ends and the surplus stock is removed with the rip saw and finished with the core box plane. The ends then are fastened on for the first method of molding. For the second method, two additional pieces are made which correspond to the thickness of the core prints in Fig. 8. These have a semicircle cut out to correspond to one-half of the cope core print in Fig. 8. These pieces are then fastened to the main portion of the core box and the ends are fastened to these two pieces.

The construction of the water jacket core box is shown in Figs. 10 and 11. When making this box, first cut out heads *C* and *E*, Fig. 10, and lay out semicircles about 1½ inches larger than the outer diameter of the water jacket; cut these right to the line. The center of these semicircles is raised above the edge of *C* and *E* equal to the thickness of *I* and *K*, Fig. 11. In the lower right and left corners of *C* and *E* cut recesses for pieces *I* and *J*, Fig. 11. These two pieces are added to strengthen the core box. Next cut the staves *D* and fit, nail and glue them in the semicircles of *C* and *E*. Then cut, fit and fasten *L* and *K*. This section is finished so that the inside circle corresponds to the outer diameter of the water jacket; *B* is turned on a lathe to the shape shown in Fig. 10 and is fastened to end of the main section. The semicircular piece *F* provides a guide for strike-off *H*. This should be at least 1 inch thick. The outside and inside diameters of the water jacket should correspond to the main cylinder core for the first method, and with the small diameter of the cope core print by the second method. The core box ends *A* and *G* are cut and fastened in place. This completes the core box with the exception of the strike-off and the loose pieces *I*, Fig. 11, which form the lugs shown on the water jacket end in Fig. 1. These lugs are threaded to receive stud bolts to fasten the cylinder head. Cut three pieces similar to *I* and one piece which should be one-half of *I*, that is, parting it on the center line of the lug. The length of these pieces is shown in Fig. 2. To make one complete core for the water jacket it is necessary to make one-half core with the lugs in position, as shown in the lower half of Fig. 1, using *AB* as the dividing line, and another half core is made with *G* at *H* and *A* is placed the same distance to the left of *CD* as it was to the right in the first half. These lugs and their positions in the two halves should be so clearly marked that the coremaker will be unable to make any mistakes in making the cores. When the two halves are pasted together the openings in the core will coincide with the positions of the lugs in Fig. 1. The strike-off is made to conform to the inside of the water jacket, the shape of which is plainly shown in Fig. 10.

Calculating Mixtures for the Cupola

By W. J. Keep

Question:—The pig iron we are using costs $54 per ton; stove plate scrap, $25 and the 50 per cent ferrosilicon, used for making additions, cost 6 cents per pound. We would like to know how this mixture should be figured.

Answer:—We will assume that the pig iron contains 2.25 per cent silicon and the stove plate scrap, 2.50 per cent silicon. With the 50 per cent ferrosilicon as a softener, you probably can use 250 pounds of stove plate scrap in a 1-ton mixture. Your castings should contain at least 2.75 per cent silicon and up to 3 per cent would be even more satisfactory. Since 0.25 per cent silicon is lost in remelting, your mixture should contain 3 per cent of this element. The usual method of calculating a mixture is to figure one that will give you the required silicon. In a stove foundry, the remelt amounts to 40 per cent, or 800 pounds per ton, which must be used each day. If the mixture is figured to contain 3 per cent, the following is a trial calculation:

Metal	Per cent, silicon	Pounds, silicon
250 pounds of stove scrap	2.50	6.25
800 pounds of remelt.....	2.75	22.00
925 pounds of pig iron....	2.25	20.81
25 pounds of ferrosilica..	50.00	12.50
2000		61.56

The percentage of silicon contained in the mixture is 3.08, which is sufficiently close for calculating purposes. To obtain the desired result without guesswork, the following calculation is recommended, the amount of scrap and remelt previously having been decided upon:

Metal	Per cent, silicon	Pounds, silicon
250 pounds of scrap.....	2.50	6.25
800 pounds of remelt.....	2.75	22.00
1050		28.25

28.25 ÷ 1050 = 2.69 per cent silicon.
2000 x 3 per cent = 60.00
28.25
31.75

We must have 950 pounds of pig iron containing 31.75 pounds of silicon which is equal to 3.35 per cent silicon for the metal to be added. The first step in calculating the mixture follows:

3.35 { Pig iron at 2.25 per cent Si. — 1.10 / Ferro Si. 50.00 per cent Si + 46.65

4665 parts
4775
110 parts

930 pounds ÷ 4775 = 0.2 pound as one part.
4665 parts of pig iron × 0.2 = 933 pounds.
110 parts of ferrosilicon × 0.2 = 22 pounds.

Using even weights, the mixture follows:

Metal	Per cent, silicon	Pounds, silicon
250 pounds of scrap.....	2.50	6.25
800 pounds of remelt.....	2.75	22.00
930 pounds of pig iron....	2.25	20.92
20 pounds of ferrosilicon.	50.00	10.00
2000		59.17

The mixture then contains 2.95 per cent silicon. The cost of the mixture follows:

Metal	Price per ton	Total cost
250 pounds of scrap.....	$25.00	$3.125
930 pounds of pig iron...	54.00	25.11
20 pounds of ferrosilicon, per pound	.06	1.20
1200	2.45	$29.435
800 pounds of remelt would be worth.....		19.60
2000		$49.035

After a trial of this mixture you will be able to increase or decrease the amount of scrap to be used.

Pertinent Hints for Practical Patternmakers

How to Avoid Mistakes in Laying-Out Work, With Suggestions for Repairing a Brass Valve Pattern and a Convenient Work Bench

By M E Duggan

PATTERNMAKERS who never make mistakes never attempt anything. Mistakes are bound to be made, both in planning and executing, but I have found the following method of great help in correctly transferring my drawing to my work and hence avoid many mistakes.

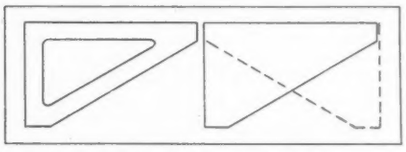


FIG. 1—CORRECT RELATIVE POSITION BETWEEN THE WORK AND THE DRAWING ON THE BENCH

The first thing to remember is always to read a dimension correctly the first time. This is of the utmost importance because first impressions are generally lasting ones. Suppose the patternmaker glances casually at his blueprint and reads a dimension as 12¼ inches. After repeating this to himself a few times he again looks at his blueprint and discovers that he is in error, the dimension is 12¾ instead of 12¼ inches. In a case of this kind it is essential for the patternmaker to exercise due caution, or he will find himself working to the wrong dimension because it was fixed in his mind at the start.

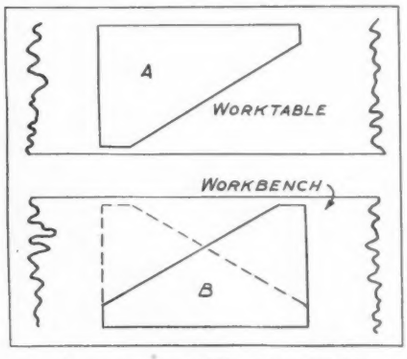


FIG. 2 — THE SAME PRINCIPLE AS SHOWN IN FIG. 1 APPLIED TO LARGER WORK

The patternmaker who cannot depend upon himself to read dimension arrows correctly should trace the dimension lines with his finger. Also, every patternmaker should train himself to judge distances. For example, if the dimension wanted is 10 inches and the patternmaker lays off 9 inches by mistake, he should be able to detect the error at once.

Another aid in accurately transferring dimensions and positions to the work is to arrange the drawing and the work in the same relative positions. This is illustrated in Fig. 1. The drawing is at the left and the pattern to be laid out, at the right. The dotted lines at the right show the wrong way that leads to mistakes, while the solid lines show the correct relative position between the work and the drawing.

To Lay Out Large Work

A larger job is shown in Fig. 2. In this case the drawing is placed on the work table while the pattern is laid out on the work bench. The patternmaker stands between the bench and the table. The relative positions between the drawing *A* and the work *B* are clearly seen. The dotted lines show the wrong way to make the layout while the solid lines show the correct method. The patternmaker should be sure he is right before he goes ahead.

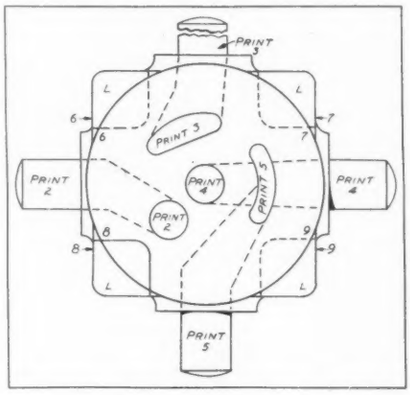


FIG. 1—PLAN VIEW OF THE VALVE FOR WHICH THE PATTERN HAD TO BE REPAIRED

Repairing a Brass Valve Pattern

The work of the molder to a large extent is predetermined by the patternmaker and, therefore, it becomes necessary that the latter should have a knowledge of foundry work. Recently I was asked to repair an old pattern for a brass valve and it was evident that the patternmaker who made the original model did not take into consideration the subsequent foundry operations. This pattern had 11 loose pieces and four ports were provided in the core. The valve was shown by five views on the drawing that accompanied the pattern. A

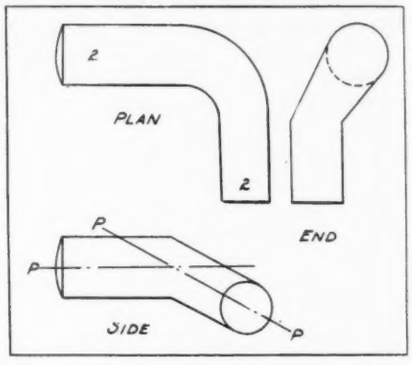


FIG. 2—PLAN, END AND SIDE VIEWS OF ONE OF THE CORES

plan view of the valve is shown in Fig. 1, the body being indicated by the dotted lines. Eight bolt lugs, four at the bottom and four at the top of the body, are shown at *L*. Why these were made loose on the pattern is a mystery to me and from the way the model was constructed it is evident that the patternmaker either was careless or did not understand patternmaking or molding.

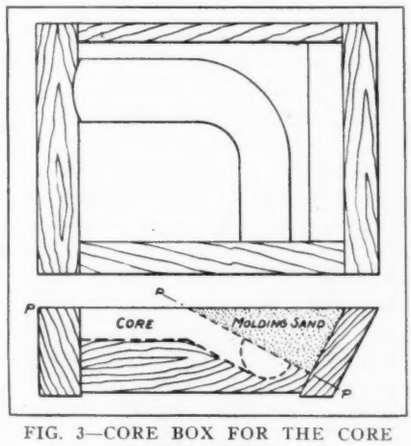


FIG. 3—CORE BOX FOR THE CORE SHOWN IN FIG. 2

With the pattern, eight half core boxes originally were provided, but three of these were lost and I had to replace them. In this connection, I want to direct attention to the necessity of maintaining an accurate record of all changes or alterations made in either patterns or cast-

ings. The port openings in this valve were changed since the original pattern was made, but these changes were not recorded and I was expected to make the new core boxes conform to these changes. The changes were not indicated on the drawings, the valve to be replaced was in use on a machine and I had nothing to guide me as to how these core boxes should be made.

The loose pieces *L*, Fig. 1, all varied in form and their identification marks were so carelessly indicated that the correct matching of the loose pieces onto the body of the pattern puzzled the molder. I remarked these loose pieces with raised figures. These were attached to the outside of the pattern as indicated by figures *6*, *7*, *8* and *9*, Fig. 1. The core prints and core boxes were marked in the same way. The method of identifying the core boxes is indicated in the plan view, Fig. 2. The figure *2* was fastened in the core box and its impression was made in the core thereby simplifying the core setting operation. Plan, end and side views of one of the cores is illustrated in Fig. 2.

One-half of the core box for the core shown in Fig. 2 is illustrated in Fig. 3. Owing to the bend in the core, it was necessary to dry it on a bed of sand. It is common practice to shape such a core box as indicated by the line P. A jacket was made out of rough lumber which was fitted loosely around the core box. Sand was filled-in on top of the core as shown in Fig. 3, and when the core was rolled-over onto the dryer this sand supported the core during the baking process. It is common practice for the coremaker to make these jackets, but it is no more his duty to produce these sand boxes than to make the core boxes.

Brief reference should be made to the complicated drawings that frequently are delivered to the patternmaker. The designer, of course, is familiar with all of the dots, dashes, straight and curved lines, etc., but it seems to me that frequently these drawings are entirely too involved for the patternmaker, molder, machinist and erecting engineer to follow. Drawings should be made clear and plain so that they can be read easily by the men who are to work from them.

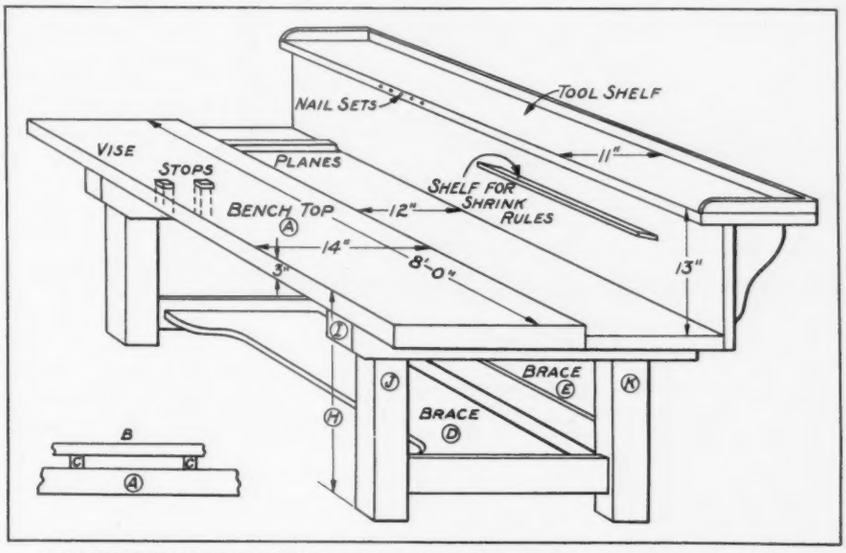
A process for coating metals recently patented by Benjamin P. Allen, Great Neck Station, N. Y., consists of immersing the articles in a bath composed of water, 80 cubic centimeters; acetic acid, 10 cubic centimeters, and lead chromate, 40 grains. A current of electricity is passed through the bath and the articles and a yellow coating results.

A Patternmakers' Work Bench

The superintendent of a large plant which employed from 8 to 15 patternmakers, during one of his tours of inspection through the pattern shop pointed out to the foreman that no two work benches were alike in design or construction. He stated that it was his impression that each patternmaker has some improvement or alteration to make to his bench, thereby imparting to the pattern shop the appearance of a second hand store. It is rather unusual for a works superintendent to interest himself in the pattern shop in this way, yet a visit to many a loft where patterns are made, impresses one with the poor arrangement of machinery, much of which is second-hand junk. In many pattern shops the working conditions are so unsatisfactory that they greatly interfere with operations and retard production.

Several years ago I obtained a position in a pattern shop and was directed to a bench by the foreman patternmaker, which was not too inviting. I am not exaggerating the condition of this bench when I state that the top had a coating of glue and shellac, ⅛-inch thick. I started to remove this with a scraper and a plane and was immediately stopped by the foreman who told me that it was unnecessary to do this and insisted that I was wasting valuable time.

A work bench which I consider to be strong, practical and convenient for patternmakers' use is shown in the accompanying sketch. The details of construction are too simple to warrant further explanation. The cross-pieces *I* and the legs *J K* are made from 4 x 4-inch timber. The top is 3 x 14 x 96 inches and 1½ x 12 x 96 inches. The back is made of 1-inch stock and is provided with a shelf for shrink rules while the tool shelf is made of 1-inch material with a 3-inch border around the edge. It will be noted that the usual brace across the front of the bench is eliminated and no provision is made for drawers. As a rule, drawers merely are receptacles for a lot of waste material which is never used and anything placed in them never can be found when wanted. Therefore, I am opposed to drawers in patternmakers' benches. Planes are the only tools kept on top of this bench, while small tools, chisels, gouges, etc., are placed on the tool shelf. Nail sets, center punches, etc., are kept in holes drilled on the tool shelf. Storing small pieces of scrap lumber under the bench is a habit with some workers, but this is forbidden in many shops. In the left hand corner of the accompanying illustration is shown a cross-section of a double top for a bench, this arrangement saving the top *A* while *B* is a pine plank which can be dressed easily and kept true.



A PATTERNMAKER'S BENCH WITHOUT DRAWERS AND THE CUSTOMARY BRACE AT THE FRONT

New Aluminum Solder

In pouring manganese bronze it is not necessary to get the metal so hot that it flares like unaluminumized yellow brass. For most castings, if the alloy has a blood-red appearance and smokes when the surface is broken by the skimmer, it will be sufficiently hot to produce good castings.

An alloy of nickel and copper, recently patented, consists of the following metals: Nickel, 67.8 per cent; copper, 28 per cent; manganese, 2.5 per cent; iron, 1.5 per cent, and vanadium, 0.2 per cent. This alloy is claimed to be suitable for making noncorroding springs, or polished metal sheets.

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Pig Iron Distribution

OF paramount importance to foundrymen is the allotment of pig iron for nonessential products the remainder of the year. The war industries board has delegated to the blast furnace operators the authority to make the distribution of their tonnage remaining after the essential or government needs have been filled. The iron producers will be guided by the reports filed with them by the casting manufacturers, which show the percentage of output taken for war and allied purposes and for these requirements deliveries first will be made. This step relieves the war industries board of a tremendous amount of detail which otherwise would have been entailed in the distribution of blast furnace output. The filing of priorities also is eliminated. How much iron will be available for nonessentials, of course, depends upon our needs for war purposes. The program constantly is expanding and already surpasses the possible output of our iron and steel plants the balance of the year. Material that does not comply with specifications will be made, and this will be available for the manufacturers of nonessentials. In comparison with the total output, this tonnage will be small and will take care of only a small part of the iron consumption of the plants not on the preference list. No definition of nonessentials has been made by the war industries board, other than the bulletin issued early in June, which scheduled the order of essentials on the preferential list. Furthermore, it is doubtful if such a definition will be made. As defined today, all materials for war purposes, shipbuilding and for the railroads are given preference and all other needs are of secondary consideration. Foundrymen without adequate stocks already are beginning to feel the effects of this ruling and are tiding themselves over with an increased consumption of scrap. Casting producers who operate their plants scientifically and who make mixtures by analysis will be able to adapt their operations to the new conditions.

Sand-Blast for Platers

WITH the growing scarcity and increasing cost of acids used by platers for cleaning cast and other metal parts preparatory to coating, other methods must be adopted that will serve the purpose equally well. Wherever tried, the sand-blast has given excellent results and in many instances it produces a surface far superior to that which may be obtained by any cleaning or acid solution. The sand-blast removes all oxide, scale, etc., uniformly and no part of the object must be exposed to its action for a longer period than any other because of adherent scale, which so frequently is the case in the use of acid solutions. Furthermore, the sand-blast is without the disagreeable features of the cleaning tanks and the equipment occupies less space. No poisonous fumes are emitted that are so injurious to health, nor does the sand-blast produce the "sloppy" condition so prevalent in the cleaning departments of plating shops. To conserve the acid supply the advantages of sand-blast for cleaning purposes merits the thoughtful consideration of every plater.

Comings and Goings of Foundrymen

J. K. Williams has resigned as president of the J. K. Williams Foundry & Machine Co., Akron.

F. J. Nicholas has resigned as treasurer and purchasing agent of the Sandusky Foundry & Machine Co., Sandusky, O., to accept an important position with the Calumet & Hecla Mining Co., Calumet, Mich.

Frederick W. Heiser has resigned as assistant superintendent of the Zanesville Malleable Foundry Co., Zanesville, O., to become superintendent of the Canton, O., malleable foundry of the Timken-Detroit Axle Co.

A. V. Magnuson, affiliated with the molding machine business for over 20 years, has become actively identified with the molding machine department of the Davenport Machine & Foundry Co., Davenport, Iowa.

H. Johnson has been appointed superintendent of the Lakeside Foundry Co., Detroit, producer of motor car castings. For a long time he was superintendent of the Fairview Foundry Co., controlled by the Chalmers Motor Co., Detroit.

J. W. Livingston was recently made foundry superintendent of the Gile Tractor Co., Ludington, Mich. He formerly was connected with the foundry operated by the Studebaker Corp. and later with the Campbell Mfg. & Foundry Co., Muskegon, Mich.

Louis Rasmussen, who formerly was affiliated with the Manitowoc Aluminum Foundry Co., and later with the Simms Foundry Co., Racine, Wis., has been apponted foundry superintendent of the Campbell Mfg. & Foundry Co., Muskegon, Mich.

George V. Moore, formerly affiliated with the Robeson Process Co., New York, is now connected with the Marden, Orth & Hastings Corp. of that city, which is developing liquid and dry core binders that shortly will be placed on the market.

Alexander Blackwood, formerly affiliated in an executive capacity with the Michigan Steel Casting Co., Detroit, and who later organized the Blackwood Steel Co., Springfield, O., recently has been appointed general manager of the Union Steel Casting Co., Boston.

George Neilson is foreman of the foundry recently placed in operation by the Hurley Machine Co., Cicero, Ill., a suburb of Chicago. This plant employs 35 molders and specializes in washing machine castings. C. A. Russell is purchasing agent.

Thomas McCarthy has been appointed foundry superintendent of the new castings shop of the Universal Machinery Co., West Allis, Wis. This plant will be placed in operation about the middle of September and will employ approximately 35 molders. J. E. Purdy is secretary.

George H. Crossan, who formerly was identified with the purchasing department of the General Electric Co., Lynn, Mass., is now acting in the capacity of director of purchases for the General Vehicle Co., Aeronautical Engine Corp., and the Wright-Martin Aircraft Corp., Long Island City, New York.

W. B. George, who formerly was affiliated with the Greenwald Foundry Co., Cincinnati, has purchased an interest in the Frisbie Engine & Machine Works, 33 East Water street, that city. The latter company is noted in the marine field and new facilities will be installed to take care of Ohio river steamers.

A. Niedermeyer, who for many years has been connected with the Worthington Pump & Machinery Corp., New York, most recently as works manager of the Snow-Holly works at Buffalo, resigned recently to devote his entire time to enterprises of his own.

W. T. Woodrow has been appointed manager of the Manitowoc, Wis., plant of the Aluminum Castings Co., Cleveland. He succeeds Howard Emery, who recently was transferred to the Detroit plant, of which he had charge prior to going to Manitowoc several years ago.

B. L. Weaver, who has been connected with steel work operations for nearly a quarter of a century, latterly as superintendent of the steel foundry department of the Steelton, Pa., plant of the Bethlehem Steel Corp., resigned recently. He has assumed charge of the locomotive plant of the Vulcan Iron Works, Wilkesbarre, Pa.

Charles B. Wilson, president and general manager of the Wilson Foundry & Machine Co., Pontiac, Mich., has entered the government's service. He is assistant manager of aircraft production and has charge of airplane production at the plant of the Curtiss Airplane & Motor Corp., Buffalo.

E. J. Leisser, until recently production manager of the International Harvester Corp., Milwaukee, has been appointed manager of this company's foundry. Paul F. Schryer is plant manager. Every effort will be made to double the output of this plant by the installation of additional labor-saving machinery.

J. H. Cheetham, formerly affiliated with the McNab & Harlin Mfg. Co., Patterson, N. J., has assumed his new duties as superintendent of the E. B. Kunkle Co., Fort Wayne, Ind., manufacturer of brass escapement and safety valves. The output of this plant will be doubled and considerable new machinery will be purchased to facilitate production.

Joseph P. Cleal, formerly connected with the National Cash Register Co., Dayton, O., has been appointed general superintendent of the L. Wolff Mfg. Co., Chicago. F. G. Hazeldine, formerly superintendent of the Findeisen & Kropf Mfg. Co., has been appointed assistant superintendent of the Wolff Mfg. Co. This plant now is largely engaged on government work.

L. C. Sprague is now special representative in New York in connection with the sale of pneumatic tools to railroads for the Chicago Pneumatic Tool Co., Chicago. Mr. Sprague was formerly connected with the Tool company but more recently has been connected with the railroad department of the H. W. Johns-Manville Co., New York.

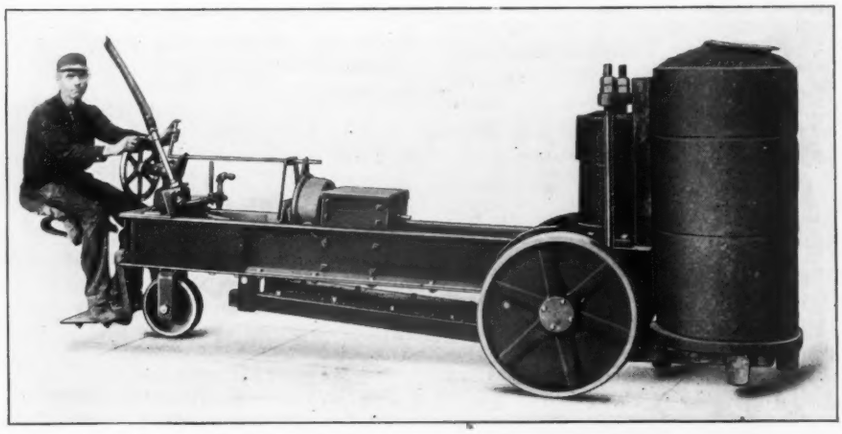
Robert Snow has been appointed superintendent of the Great Lakes Foundry Co., Port Huron, Mich., formerly Theisen & Braithwaite Co. He recently resigned as foundry superintendent of the Detroit Foundry Co., and Foundry & Machine Products Co., Detroit, with which allied concerns, he has been affiliated for several years.

W. P. Pressinger, manager of sales, and W. H. Callan, manager of plant and operation of the Chicago Pneumatic Tool Co., Chicago, have been elected vice presidents by the board of directors. J. T. Price remains as vice president and J. G. Osgood, formerly vice president, is dropped from the list, remaining with the company as director of sales of pneumatic tools.

Theodore H. Harvey resigned recently as general manager and assistant secretary of the Pelton Steel Co., Milwaukee, to accept the position of

general manager of the Ohio Steel Foundry Co., Springfield, O. Mr. Harvey assumed his new duties July 1. William H. Schuchardt vice president and secretary of the Pelton Steel Co. has taken charge as general manager.

H. E. Stocker, who has been production manager of the Fort Wayne work of the General Electric Co., tendered his resignation recently. He will become general manager of the International Clay Machinery, Dayton, O. He has been succeeded at Fort Wayne by J. H. Evans, present head of the cost and accounting department of the General Electric Co.'s plant in that city.



AIR-OPERATED MALLEABLE IRON ANNEALING OVEN CHARGING TRUCK BUILT BY THE BROWN SPECIALTY MACHINERY CO.

B. F. La Follette resigned recently from the service of the Clarage Fan Co., Kalamazoo, Mich. He had charge of the engineering, sales and advertising departments and on July 1 will commence to work for the government. He will be located either in Philadelphia or Washington as an engineer with the requirements division of the United States shipping board, Emergency Fleet corporation.

Arthur H. Young, director of the American Museum of Safety, New York, has resigned to take charge of the employes relations department of the International Harvester Co., Chicago. In recognition of Mr. Young's accomplishments as chief safety expert of the federal government, the Museum has awarded him the Louis Livingston Seaman medal. Mr. Young will be succeeded by R. M. Little, formerly a trustee of the Museum.

Henderson W. Knott, who formerly was general manager of the Morgan Crucible Co., New York, has been appointed by the United States fuel administration to manage the field force of engineers and inspectors at work among the power plants of the country. A campaign of instruction and inspection is being carried out to bring the use of fuel for the production of power to the higest possible degree of efficiency and economy.

W. W. Coleman who is president of the Bucyrus Co., Milwauke, Wis., has been designated to assist a group of expert advisers in the ordnance department in bringing about a maximum production of guns, gun carriages and munitions. Mr. Coleman will specialize in the production of guns of all calibers and of gun carriages. He will be associated with A. L. Humphrey, president of the Westinghouse Airbrake Co., Pittsburgh, in this phase of the work.

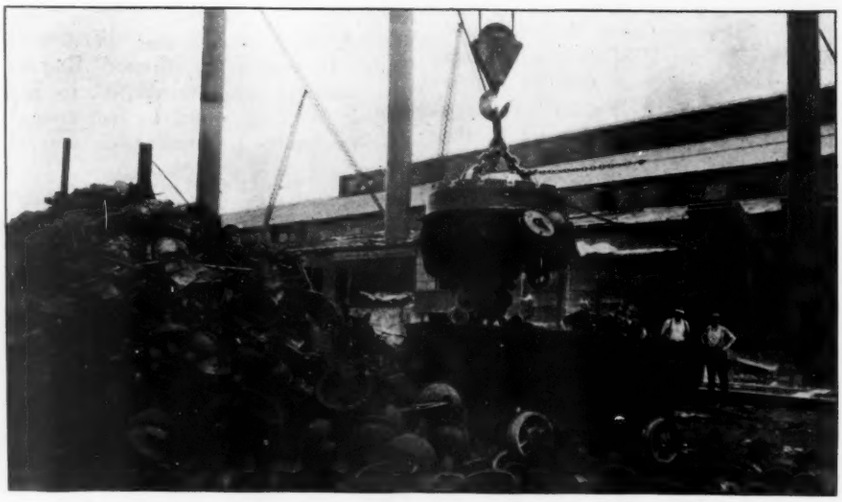
The Industrial Electric Furnace Co., Chicago, is installing two single-phase Snyder electric furnaces to be operated together on a polyphase current system, in the plant of the Western Steel Car & Foundry Co., Chicago. The furnaces will have a capacity of 1½ tons each and acid steel will be produced.

A New Charging Truck for Malleable Iron Foundries

In the accompanying illustration is shown a truck for charging stacks of castings into malleable iron annealing ovens. It is operated by compressed air and is substantially constructed. The main frame consists of two steel channels from which are suspended the 4-inch steel elevating and lowering arms that are equipped with removable cast steel tangs for picking up the sacks of charging boxes. These tangs may be replaced readily when worn. The arms are raised by an air cylinder controlled from the operator's seat. A reversing air motor drives the truck, through a set of reduction gears and a standard motor truck differential, to pinions engaging in the internal gears on the driving wheels. The truck is guided by a standard motor truck steering worm, so arranged that the truck can turn in its own length. The air hose is suspended overhead. The air consumption is only 80 cubic feet per minute and the operating speed 90 to 120 feet per minute. This truck is built by the Brown Specialty Machinery Co., Chicago.

Magnet Has Welded Connections

Two troublesome features which have long characterized electro-magnets are grounds, more familiarly known as open ends and short circuits, and loose and broken bolts, the latter leading ultimately to the breaking of the renewable outer rings. Both may be attributed to the loosening of internal screw and nut connections caused by the severe vibration and jolts to which magnets are subjected.



NEW TYPE OF MAGNET CONTAINING WELDED CONNECTIONS AND ASBESTOS INSULATION AT WORK ON FOUNDRY STOCK PILE

To eliminate to as great a degree as possible these undesirable factors, the Ohio Electric & Controller Co., Cleve-

land, recently placed on the market a lifting magnet in which all connections are welded and all insulation asbestos. The magnet ring is over 8 inches high and is secured by heavy chrome, vanadium steel studs with nuts on the top of the case protected by ribs raised from the outer rim of the cast-steel case. The accompanying illustration shows one of these magnets at work on a stock pile of castings in a foundry yard.

Soldering Aluminum

A process for soldering aluminum has been invented by Walter Overend, Finsbury Park, Eng. It consists of preparing the surface of the aluminum by heating it and applying a flux of stearic acid. An alloy of tin and zinc then is applied, which is fused onto the aluminum at a temperature of approximately 750 to 800 degrees Fahr. This tinning process is facilitated by rubbing the tin and zinc composition onto the aluminum with a soldering iron. This removes the oxide from the aluminum surface. After the aluminum surface has been well tinned, an alloy of tin and cadmium is used for the final sweating or soldering; stearic acid is used for a flux.

Open-Flame Furnace for Melting Nonferrous Metals

For melting brass and other nonferrous metals, the Hausfeld Co., Harrison, O., recently developed the furnace shown in the accompanying illustration. This unit is of the open-flame, noncrucible tilting type with a melting capacity of 400 pounds. It is designed to use either gas or oil and the change from one to the other it is claimed may be made readily as occasion requires.

The complete unit consists of the furnace proper, burner, ½-horsepower motor, fuel-oil feed and a pouring ladle. No other equipment except the piping to the gas or oil line is necessary.

The oil feeder develops a lift of over 18 feet and has a delivery pressure of 60 pounds. It is provided with an outlet pipe which connects with the oil reservoir. This feature permits the return of any excess quantity of oil.

The burner preheats the oil prior to its injection into the furnace. The needle valve is installed at the extreme end of the burner outlet and produces a spray of wide range.

To increase this range, and to break large particles of oil, a small division bar is located directly in front of the burner outlet. With this arrangement it is claimed, all the oil supply is utilized and as the oil is preheated and finely atomized, it ignites quickly. The flame covers the entire inner surface of the furnace which gives a uniformly distributed heat. It is poinited out that the plain shape of the drum facilitates relining. The bricks furnished have interlocking joints which prevent the seepage of metal.

The pouring ladle is held in slots over the notch where it remains during the melting of the entire heat. By this arrangement the ladle is heated to a high temperature. This feature is also said to aid materially in retaining the heat within the furnace.

The furnace is tilted by means of a handle of sufficient length to insure ample leverage for easy manipulation. The locking arrangement is actuated by a spring which has a tendency to keep a bar on the frame in constant engagement with the teeth of a sector attached to the drum. This securely holds the drum in any position desired.

The release of the locking device is effected by foot pressure on a treadle at the base of the unit. This permits the use of both hands for tilting or rocking the drum. For convenience, a double treadle is provided one end of this treadle extends to the front and the other end to the rear of the operating side so that, when tilting, the most convenient treadle is used. Upon release of the foot pressure, the drum is locked instantly.

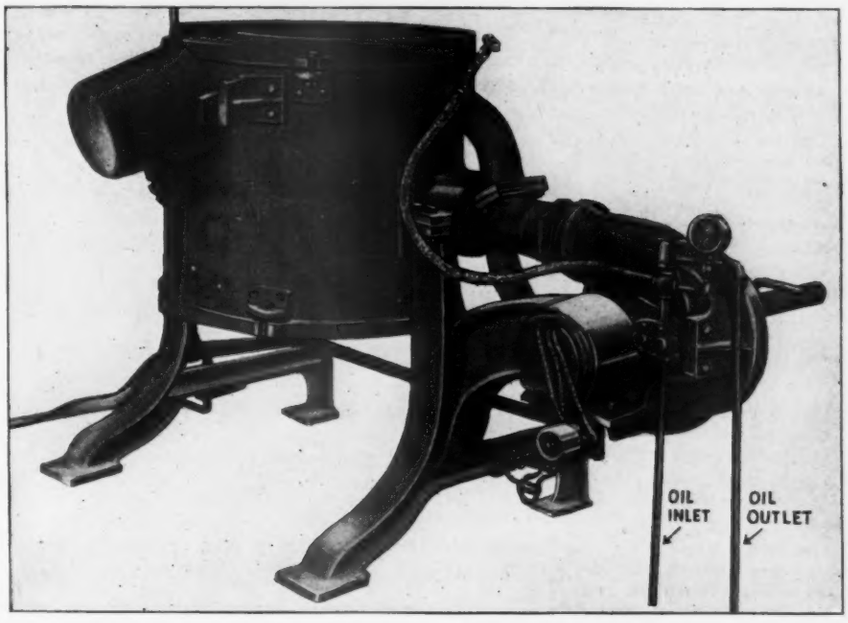
When the furnace is in a vertical position, it can be charged while the blast is on. The metal is preheated on the top of the drum, after which it is charged into the furnace by means of a bar, as fast as desired.

A New Refractory Material

A refractory material for furnace lining, has recently been patented by Charles B. Stowe, Cleveland. It is claimed that the material is useful for the manufacture of all kinds of molded articles which are subjected to high temperatures, such as furnace brick, gate molds for thermit castings and other special shapes of molded articles used in the linings of furnaces, ladles, retorts, crucibles, etc.

The process consists of making bricks or other shapes from moist magnesium carbonate or magnesium oxide after which they are coated with pulverized iron ore or with pulverized rolling mill scale and then burned.

During the burning process, the temperature is raised to a point where a portion of the iron oxide is absorbed by the article and unites with the magnesium oxide, forming a coating of refractory material composed of magnesium oxide and iron oxide, with traces of silica and calcium oxide, if these are present in the original materials. The outer surface is composed of iron oxide only and the burned bricks or other shapes have the appearance of iron castings. It is claimed that bricks and shapes made by this process are hard and dense and that they are mechanically strong enough to be used in furnace linings.



A COMPACT OPEN-FLAME METAL MELTING FURNACE

A tool steel alloy recently patented by James Heber Parker, Reading, Pa., consists of cobalt, from 30 to 35 per cent; 50 to 70 per cent of iron and 8 to 20 per cent of tungsten. Vanadium is added from 0.5 to 2.5 per cent.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Stroh Castings Co., Detroit, is planning to build an addition to its foundry.

The Milwaukee Die Casting Co., Milwaukee, will build an addition to its foundry building, 50 x 60 feet.

The gray iron foundry at Cedarburg, Wis., owned by the Western Rope & Mfg. Co., Milwaukee, is being doubled in size.

The Maynard Electric Steel Casting Co., Milwaukee, is building a foundry, 86 x 200 feet.

The Adirondak Steel & Foundry Corp., Watervliet, N. Y., is reported contemplating the erection of a new plant.

The Wilson Foundry & Machine Co., Pontiac, Mich., will build a 1-story machine shop addition, 41 x 169 feet.

The Michigan Steel Castings Co., Detroit, is building a foundry addition and car shop, 90 x 125 feet.

The Yale & Towne Mfg. Co., Stamford, Conn., has let the contract for the erection of an addition to its foundry.

The Pacific Foundry Co., San Francisco, is contemplating the erection of an addition to its foundry to cost $45,000.

The Chelsea Foundry Co., Chelsea, Mass., will build a 60 x 100-foot addition to its foundry.

The Mahoning Foundry Co., Youngstown, O., has broken ground for the erection of a foundry and storage house.

The Aluminum Castings Co., Detroit, is said to be contemplating the erection of another foundry, 50 x 100 feet.

The Portland Foundry Co., Boston, is said to be contemplating the enlargement of its plant.

The Central Radiator Co., Lansdale, Pa., is having plans prepared for the erection of a $5000 addition to its core room.

The Strong Steel Foundry Co., Buffalo, is receiving bids for the erection of a foundry, 50 x 300 feet, with an ell, 12 x 18 feet.

William Huskamp, Seattle, has a contract to erect a foundry, 43 x 114 feet, which will be erected at a cost of $5000.

The Universal Machinery Co., Milwaukee, has awarded the contract for the erection of a new foundry and core room to the Michie Construction Co.

The Montgomery Foundry & Mfg. Co., Braddock, Pa., has been incorporated with headquarters at Pottstown, Pa. It is capitalized at $100,000.

The Deane Steam Pump Works, Holyoke, Mass., has let the contract for a brick and steel, 90 x 200-foot addition to its machine shop and an 80 x 180-foot foundry.

The Valveless Pump & Foundry Co., Portland, Oreg., has leased the property of the Star Sand Co. and will begin the immediate construction of a machine shop and foundry.

The American Foundry Co., Seattle, which is headed by Sumner K. Prescott, has obtained a permit to erect a foundry at a cost of $10,000.

The Northwestern Steel Corp., Minneapolis, has bought from the Franklin Park Foundry Co., Chicago, its malleable iron foundry group and a site of 10 acres. The plant is to be improved and put into operation at once.

The Great Lakes Foundry Co., Detroit, is said to be contemplating the erection of large additions in order to make the plant a 50-ton foundry for motor car castings.

The Bond Foundry & Machine Co., Manheim, Pa., recently let a contract to N. W. Ginrich, Manheim, for the erection of a pattern shop, to cost $10,000.

The McCairns Foundry Co., Connellsville, Pa., will build an addition to its plant, 60 x 65 feet, to cost $10,000. The general contract was let to C. Paterson.

The Essen Foundry Co., Avenue D and Murray street, Newark, N. J., is contemplating the erection of a brick and steel building, 75 x 180 feet, to cost approximately $25,000.

The Gulowsen Grei Engine Co., Seattle, is contemplating the erection of a factory building, which when completed will represent an investment of $500,000. A foundry is included in the improvements.

The Peerless Foundry Co., Cincinnati, let the contract to the Marcus Building Co. for the erection of two buildings, respectively 120 x 200 feet and 60 x 120 feet, to cost $75,000.

William Hoffman Jr., Chicago, is drawing plans for a foundry 60 x 150 feet and a tool room, 30 x 34 feet, at Forty-eighth and Morgan streets. The owner's name is being withheld.

The Mueller Metals Co., Port Huron, Mich., is contemplating the erection of a tube mill, rod mill, foundry and office building, to be three stories, and of brick construction. The company is in the market for new equipment.

Architect John Carrigan, Seattle, has finished plans for the construction of a foundry and machine shop building, 43 x 114 feet, for P. J. Appleton. The building will be two stories and of heavy frame construction.

Estimates are being made on two machine shops and an open-hearth plant to be of brick, concrete and steel construction, for the Midvale Steel & Ordnance Co., at Nicetown, Pennsylvania.

The David Bradley Mfg. Co., Bradley, Ill., temporarily has deferred the erection of a malleable iron foundry. Malleable iron castings will continue to be purchased from outside shops, as in the past.

Ground has been broken by the Hercules Steel Castings Co., Milwaukee, for its new electric steel foundry. The main shop will be 90 x 275 feet. A 5-ton electric furnace and a 10-ton crane has been ordered, as well as other new equipment.

Entire control of the Davis Mfg. Co., West Allis, Wis., has been acquired by the Avery Co., Peoria, Ill. The Davis plant has been producing tractor engines for the Avery Co. F. N. Davis will continue in the capacity of general manager of the Davis plant.

The Burnside Steel Co., Chicago, shortly will erect a 60 x 250-foot extension to its converter steel casting plant. J. M. Bossini is superintendent of this foundry and L. Powell, formerly affiliated with the Blackwood Steel Co., Springfield, O., is foundry foreman.

Additions which will double its capacity will be erected by the Gerlinger Steel Castings Co., Milwaukee. Contracts have been awarded for the erection of a brick and steel foundry addition, 80 x 200 feet. Orders have been placed for a 3-ton electric furnace and a 5-ton electric crane.

After several months delay the Standard Steel Corp., Milwaukee, has been able to proceed with the erection of its plant. Architect F. D. Chase has completed plans. The buildings will consist of a brick and steel foundry, 40 x 140 feet, and a machine shop, 60 x 200 feet, two stories high, of brick, steel and reinforced concrete construction.

The Saginaw Malleable Iron Co., Saginaw, Mich., will double the capacity of its foundry by the immediate erection of an additional building, 140 x 400 feet and an extension to its power house. The cost of these additions will be approximately $125,000. The work is being handled by Frank D. Chase, Inc., Chicago, industrial engineers, who designed the original plant.

The General Motors Corp., Saginaw, Mich., will erect a new foundry for the production of automobile castings. The first unit of the plant will comprise a foundry building, 163 x 440 feet; core building, 100 x 400 feet; cleaning room, 110 x 265 feet; pattern shop and storage room, 100 x 120 feet; sand storage buildings and a power house. The cost of this unit will be about $1,100,000 and additional units will be added later. Frank D. Chase, Peoples Gas building, Chicago, are the engineers in charge of this work.

McCord & Co., Chicago, formerly large producers of miscellaneous converter steel railroad castings, are engaged almost entirely on both direct and indirect government work, including castings for tractors, gun mounts and shells. The plant organization recently was changed considerably. H. D. Taylor, formerly works manager of the Eddystone, Pa., plant of the Remington Arms & Ammunition Co., has been appointed general manager and A. W. Gregg and J. A. Anderson, formerly with the Bucyrus Co., Milwaukee, were appointed works manager and foundry superintendent, respectively. A second 7-ton Ludlum electric furnace will be installed in the near future.

New Publications

BLOWERS.—The Clarage Fan Co., Kalamazoo, Mich., is distributing a 16-page bulletin describing its latest type pressure blower. The latter is especially suited for operating at high speeds and against moderately high pressures. It is completely encased in a housing of steel plates and operates against pressures as low as 1 inch and as high as 20 inches. The bulletin contains numerous capacity tables which give an idea of the range of each size of fan.

POWER PUMPS.—A 56-page catalog has been issued by the Deane Works of the Worthington Pump & Machinery Corp., New York, which is devoted to vertical triplex power pumps, both single and double acting. This line of pumps has been manufactured for many years but the 1918 models embody many improved features. The catalog is well illustrated and contains detailed descriptions of these pumps, their design and construction. Tables of capacities also are included.